D. J. McGaukey

1914

SURGERY OF THE UPPER ABDOMEN

DEAVER AND ASHHURST

VOLUME II

IN ACTIVE PREPARATION

SURGERY OF THE LIVER, GALL BLADDER, PANCREAS, AND SPLEEN

SURGERY OF THE UPPER ABDOMEN

IN TWO VOLUMES

BY

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VOLUME I

SURGERY OF THE STOMACH AND DUODENUM

With 76 Illustrations

Several of which are Printed in Colours

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TO THE
MEMORY OF

BILLROTH
TERRIER
MIKULICZ

PREFACE.

There has been no department of surgery which has attracted more attention, in recent years, than the surgery of the upper abdomen. Numerous monographs, dealing with various phases of the subject, have been published in English, in French, in German, and in other modern languages. It seemed to the authors that a stage had been reached when it would not be without value to review this subject, and to present to the profession the results of their studies, as well as an expression of opinion based on these studies and on an experience, which has not been very limited, with the treatment, operative and otherwise, of the surgical lesions of the stomach, duodenum, liver and bile passages, pancreas, and spleen.

The present volume comprises the surgery of the stomach and duodenum; and it is hoped that the publication of the second volume will not be long delayed.

An immense mass of literature has accumulated within recent years dealing with the surgery of the stomach; and to consult all of this, and to sift the valuable from the worthless, has been no light task. It was realized, however, that opinions based on personal work alone are at times liable to bias; and it has therefore been the endeavour of the authors, while always stating explicitly their own opinions and practices, also to present those of other surgeons; and to express their own adherence to or dissent from those views and practices, as well as the reasons therefor, with candour and sincerity. It has not been deemed advisable, nor would it have been possible in a work of this size, to give every bibliographical reference consulted; but there has been appended to each section a list of the more important references.

The descriptions of the operations employed have been made as concise as is compatible with clearness. An endeavour has been made,

and the authors venture to hope not without success, to include a sufficient number of cuts fully to illustrate the text, without converting the work into an atlas. The illustrations, which have all been drawn expressly for this volume by Mr. Chas. F. Bauer, maintain the high standard of beauty and of accuracy in detail for which his work is so well known. Many of them are original; others have been redrawn, with the alterations and additions which have suggested themselves to the authors, from such well known sources as Andrews, Bardeleben, Bennett, Caird, Cautley and Dent, Cunéo, Guibé, Mayo, Mongour, Moynihan, Musser, and Sobotta.

The authors have to thank Dr. A. D. Whiting for his very painstaking and accurate work in tracing the patients operated on at the German Hospital; for compiling the statistics derived from these cases; for kindly criticism and assistance in the preparation of the text; for his help in reading the proofs; and for the preparation of the index. Their thanks are due to Dr. P. G. Skillern, Jr., for assistance in the preparation of the chapters on Anatomy and Physiology. Without the help thus given, more than the four years already passed would have been consumed in the preparation of the volume.

J. B. D.
A. P. C. A.

December 1, 1908.

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SURGERY OF THE UPPER ABDOMEN.

CHAPTER I.

ANATOMY.

Systematic descriptions of anatomy are sought in treatises specially devoted to the subject; and what a reader desires to find in a work like the present is the surgical or applied anatomy of the parts under discussion. The histological structure of the various organs is therefore omitted, together with a detailed statement of their size, shape, and minute relations to other structures. It has seemed wise, moreover, to consider the subject of the anatomy of the upper abdomen as a whole, and not to preface the surgery of each organ with a brief anatomical outline in which there would be many repetitions required.

The Abdominal Wall.—To the operating surgeon the abdominal wall should present itself as a muscular and aponeurotic structure whose subsequent strength depends upon the skill and judgement with which it is divided and sutured during an operation. Transverse division of the muscular fibres is to be studiously avoided; but it is to be borne in mind that a firmer scar usually results when longitudinal separation of these fibres has been employed than when the incision has been made through aponeurotic tissues alone—such as the linea alba or the linea semilunaris.

The rectus muscle is attached at the costal margin as far outward as the ninth costal cartilage, and this is therefore the limit of longitudinal incisions. In its upper two-thirds the rectus muscle is about three inches broad, being somewhat narrower as it approaches the pubic spine. In the cadaver the muscle is usually less broad than during life, often measuring less than two inches in width. Outside of the semilunar line the incision should be transverse, and more or

less oblique; the fibres of the lateral muscles of the abdomen do not all run in the same direction, and any simple incision must divide one of the muscular planes obliquely. But oblique or even transverse division of one or two of the lateral muscles creates by no means so serious a wound as transverse division of the rectus muscle, since there will almost invariably be at least one muscular plane whose fibres are merely separated longitudinally, and this plane will serve as a splint and support for the others. As the fibres of the internal oblique and transversalis run very nearly parallel to each other in the upper abdominal wall, it is best to make any oblique incision in their course parallel to the margin of the ribs, and to disregard the external oblique, cutting its fibres transversely, as they run nearly at right angles to those of the deeper muscles in this situation.

The chief artery met with in the upper abdominal wall is the internal mammary or some of its terminal branches. It runs between the rectus muscle and its posterior sheath, and the larger branches are toward the middle line of the body. The lower intercostal nerves run forward transversely between the internal oblique and transversalis muscles, pierce the posterior sheath of the rectus muscle (the deep lamella of the aponeurosis of the internal oblique), and enter the rectus muscle from its deep surface. They may be cut by an incision parallel to the fibres of the rectus, and loss of contractility and even atrophy of the part of the muscle so affected has been known to follow such injury; but as a rule no impairment of function is apparent, and even if such a result should occur, the disability in the epigastric region is much less serious than in the hypogastric.

The distribution of the lower intercostal nerves is important in connection with cutaneous hyperæsthesia, muscular rigidity, and referred pain—all conditions frequently encountered in abdominal affections. The sixth and seventh nerves supply the skin in the epigastric region (the "pit of the stomach"); the eighth and ninth, that region between the epigastrium and the umbilicus (the linea transversa of the rectus muscle); and the tenth, the umbilical area. The cutaneous hyperæsthesia, referred pain, and muscular rigidity of abdominal diseases, are due, as is well known, to the overflow of the stimulation

received by the cells in the spinal cord from the diseased area. When the stimulation overflows into sensory nerve filaments, cutaneous hyperæsthesia and pain are produced; but the motor nerves are usually affected also, and hence muscular rigidity of the overlying abdominal wall is produced (viscero-muscular reflex of Mackenzie), by the same mechanism as that by which, as was long ago pointed out by Hilton, an inflamed joint is held rigid by its enveloping muscles. As the flat muscles of the abdominal wall are not innervated by a single nerve trunk, but by numerous twigs from different nerve trunks, where the viscero-muscular reflex is referred along one trunk only, merely a portion of the muscle will contract. This is not so important in the upper abdomen as in the iliac region, where such band-like rigidity has been mistaken for a palpably enlarged appendix.

The pain referred to the left shoulder blade in disease of the duodenum and stomach is thus to be explained by the connection between the pneumogastric nerves and the sympathetic ganglia on the left side. Mayo Robson and Moynihan have pointed out that as long as the gall bladder only is involved, the referred pain is felt in the right infrascapular region, but as soon as the inflammation or adhesions involve the pylorus, the pain is felt also in the left infrascapular region.

Running from the umbilicus upward, along the deep surface of the right rectus muscle, to the longitudinal fissure of the liver, is the falciform or suspensory ligament of this organ, containing between its layers the round ligament or obliterated umbilical vein of the fœtus; as well as some small veins from the epigastric vein, anastomosing with the portal system; some arterial twigs from the phrenic arteries; besides lymphatics and nerves. It is advisable, therefore, to avoid division of this fold of peritoneum when making incisions through the abdominal wall. The suspensory ligament lies close to the linea alba, and hence an incision through the outer half of the right rectus muscle will not injure it; but if an incision in the linea alba is to be extended past the umbilicus, care should always be taken to make the cut around the left margin of the navel.

Surface Anatomy.—The *umbilicus* is at the level of the third lumbar vertebra. Approximately between it and the spinal column

lies the third or transverse portion of the *duodenum*. Above the umbilicus lies the *transverse colon*, about three fingerbreadths wide, and between this and the ensiform cartilage are found the pyloric portion of the stomach, and, overlapping this, the left lobe of the liver. The longitudinal fissure of the liver, separating the left from the right lobe, is less than an inch to the right of the median line of the body. If the transverse colon sag, and hang below the umbilicus, some coils of small intestine may present themselves between the colon and the stomach, displacing the transverse mesocolon, which, as well as the gastro-colic omentum, will be found interposed between these displaced intestines and the anterior abdominal wall.

The central tendon of the *diaphragm* is found at the base of the ensiform process of the sternum, at the level of the cartilage of the sixth or seventh rib, and opposite the eighth dorsal vertebra. The lateral arches of the diaphragm rise and fall slightly during respiration, the right being slightly higher than the central tendon, and about three-quarters of an inch higher than the left arch.

The *liver* fills the right hypochondriac region, and extends through the epigastrium to the left hypochondriac region to a distance of from one to two and a half inches beyond the left border of the sternum. It may reach the left mammary line. The liver extends as high as a transverse line drawn through the lower end of the gladiolus (the mesosternum), or the base of the ensiform cartilage. The upper surface of the left lobe is on this same level (the fifth intercostal space); but the right lobe is a trifle higher and is said to reach the lower border of the fifth rib. Since the position of the liver varies slightly with that of the body, and with the movements of the diaphragm, these outlines are only approximately correct. The lower surface of the right lobe of the liver posteriorly is opposite the spine of the eleventh dorsal vertebra, and in the midaxillary line is at the costal margin; between the midaxillary line and the right semilunar line the thin anterior margin of the liver projects about one-half of an inch below the costal margin, and crosses the median line of the body in a line drawn from the ninth right, to the eighth left, costal cartilage. The gall bladder lies beneath the ninth right costal cartilage in the semilunar line, at the outer border of the right rectus muscle.

The relations of the *stomach* vary more than those of the liver. When distended, it is in contact with the anterior abdominal wall in a triangle bounded by the anterior margin of the liver, the left ninth and tenth costal cartilages, and a line drawn between the tenth costal cartilages. The cardiac orifice of the stomach is opposite a point one inch to the left of the seventh left chondro-sternal junction, at the level of the eleventh thoracic vertebra; the pyloric orifice lies beneath the liver, about three inches below the base of the ensiform cartilage, at the level of the upper edge of the first lumbar vertebra; but as the stomach becomes distended the pylorus approaches the right linea semilunaris. The line for the lesser curvature of the stomach is drawn from the position of the cardiac orifice to that of the pylorus. The line for the greater curvature extends upward and to the left from the position of the cardiac orifice to the fifth rib, slightly external to the left mammary line, and thence to the position of the pyloric orifice. The line of the greater curvature is convex downward and to the left; that of the lesser curvature is nearly vertical when the stomach is empty.

The *duodenum* is from ten to twelve inches in length, commencing at the pyloric orifice of the stomach, and ending in the jejunum at the left side of the body of the second lumbar vertebra, after having described a half circle with its convexity downward. The first portion of the duodenum, about two inches long, passes from the pyloric end of the stomach to the right, upward and backward, to the neck of the gall bladder; the second portion is about three inches in length, and extends from the neck of the gall bladder, downward along the right of the spinal column to the level of the third lumbar vertebra. Here the third portion of the duodenum commences, passing obliquely upward to the left, across the body of the second lumbar vertebra. A line drawn from a point three inches to the right of the umbilicus, to a point two inches to the left and above it, will, according to Shield, nearly indicate the position of the third portion. The fourth portion is only about an inch in length; it passes upward from the termination of the third portion, and becomes continuous with the jejunum at the origin of the mesentery.

The *pancreas* extends across the bodies of the first and second

lumbar vertebræ from the hilum of the spleen in the left hypochondriac region, to the second portion of the duodenum in the epigastric region. Its length is from six to eight inches, and its largest portion, called the head, is surrounded by the semicircle of the duodenum as a picture is surrounded by its frame; while its body crosses the spinal column, and its tail is in contact with the spleen. It lies between the cœliac axis, above, and the superior mesenteric vessels, below, these latter separating it from the transverse (third) portion of the duodenum.

Embryology.—To understand the various folds and recesses of the peritoneum in the upper abdomen it is essential to revert to the embryonal stage before this membrane has developed the perplexing conditions found in adult life. For practical purposes it is sufficient to describe the fœtal state as follows: The peritoneum is to be regarded as a closed sac filling the abdominal cavity; along the posterior part of the abdominal cavity, back of this closed sac and parallel with the spinal column, runs the digestive tract in the form of a long straight tube. At first this tube is in connection with the region outside of the abdominal cavity by means of a prolongation through the navel, known as the vitelline duct. This duct later becomes detached from the navel, but is sometimes still evident in adult life as Meckel's diverticulum. While still attached to the umbilicus it acts as a guy rope, and pulls the formerly straight intestinal canal forward in a U-shaped projection, the arms of the U being known as the upper and lower. When the intestinal tube is thus pulled forward, the closed peritoneal sac is pushed in front of it by the intestine, which becomes more or less completely covered by the peritoneum, still retaining, however, an extraperitoneal surface through which it receives its blood vessels, nerves and lymphatics. The two folds of peritoneum covering these structures, as they pass to the intestinal tube, are known as the mesentery. The upper part of the primitive intestinal tube, close beneath the diaphragm, becomes dilated, and forms the stomach; at first it lies longitudinally in the abdominal cavity, and somewhat resembles the bulb of a hand syringe in its relation to the rest of the tube. Its greater curvature lies posterior, and the pylorus is its lowest part. That portion of the primitive intestinal tube just below the stomach forms the duodenum, and from its anterior wall the liver

grows out, as a compound tubular gland. The rapid growth of the liver, and its position close beneath the diaphragm, account in large measure for the peculiar distributions of the peritoneum around it.

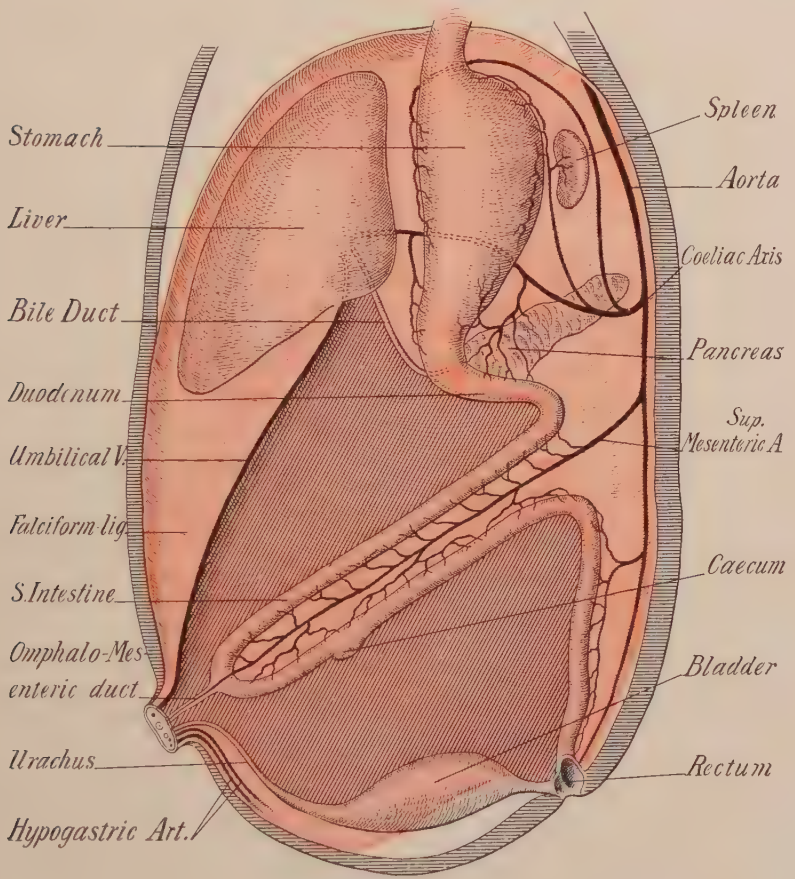

FIG. 1.—DIAGRAM OF EARLY STAGE OF DEVELOPEMENT.
The portions of the parietal peritoneum not drawn away from the body walls to form mesenteries, ligaments, etc., are indicated by deeper shading.

It developes from the anterior surface of the duodenum, and grows forward, pushing the peritoneum in front of it and downward, leaving a pedicle of peritoneum only at its origin from the duodenum and

along its inferior surface, lying, so to speak, above the closed peritoneal sac, between this membrane and the diaphragm. From the umbilicus there passes upward outside the anterior wall of the closed peritoneal sac, a vein, known as the umbilical vein, which persists in the adult as the round ligament of the liver, and which is enveloped by two folds of peritoneum known as the falciform or suspensory ligament of the liver. The urachus and the hypogastric arteries raise similar folds of peritoneum below the umbilicus. The round ligament passes to the longitudinal fissure of the liver, and when it reaches the transverse fissure blends with the portal vein, into which vessel it emptied its blood during intrauterine life.

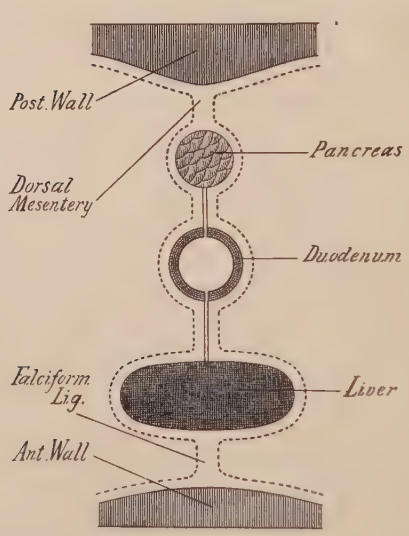

Fig. 2.—Diagram Showing Relation of Duodenum to Liver and Pancreas.

The duodenum at this period of developement has already a mesentery of its own, slight in extent, lying between it and the posterior abdominal wall, and of course continuous above with the gastric mesentery and below with that of the jejunum. Into the layers of this duodenal mesentery the pancreas grows, extending backward from the duodenum, just as the liver grows forward. Now commences a complex process of rotation of all the abdominal viscera. The lower limb of the U-shaped intestinal tube, in which the cæcum begins to bud, rotates upward in front of and above the upper limb, and the cæcal portion passes first through the umbilical region to the left hypochondriac region, thence to the right hypochondrium, and finally at birth settles down toward the right iliac region of the abdomen. This rotation of the intestine takes place from left to right around the superior mesenteric artery as an axis in such a manner that the colon crosses the commencement of the small intestine transversely. While

in this way the commencement of the large intestine is thrown over to the right side, the small intestine for the greater part assumes a position on the left, and the former right side of the mesentery becomes the

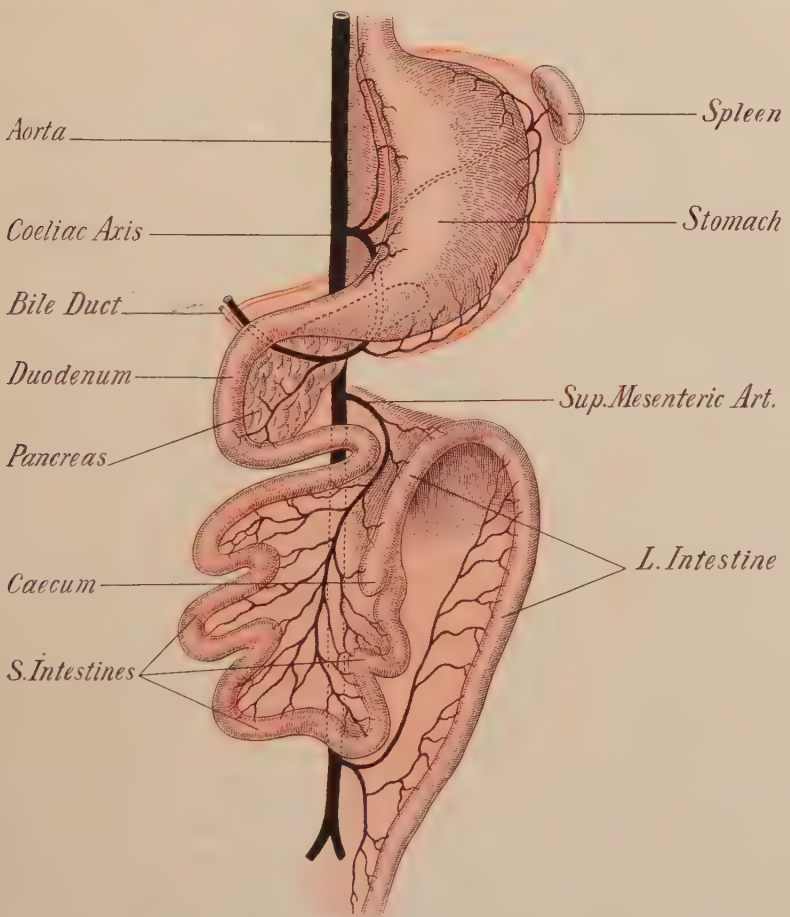

Fig. 3.—Diagram Representing Early Stage of Rotation of Abdominal Viscera.

left and *vice versa*. Thus, the lower part of the duodenum is carried to the left and the commencement of the large intestine is carried across it—an explanation of the position of the duodenum behind the trans-

verse colon in the adult, and of the passage of the superior mesenteric artery over the front of the duodenum. The influence that the rotation of the intestinal loop has upon the mesentery may be readily appreciated: the attachment of the mesentery of the small intestine

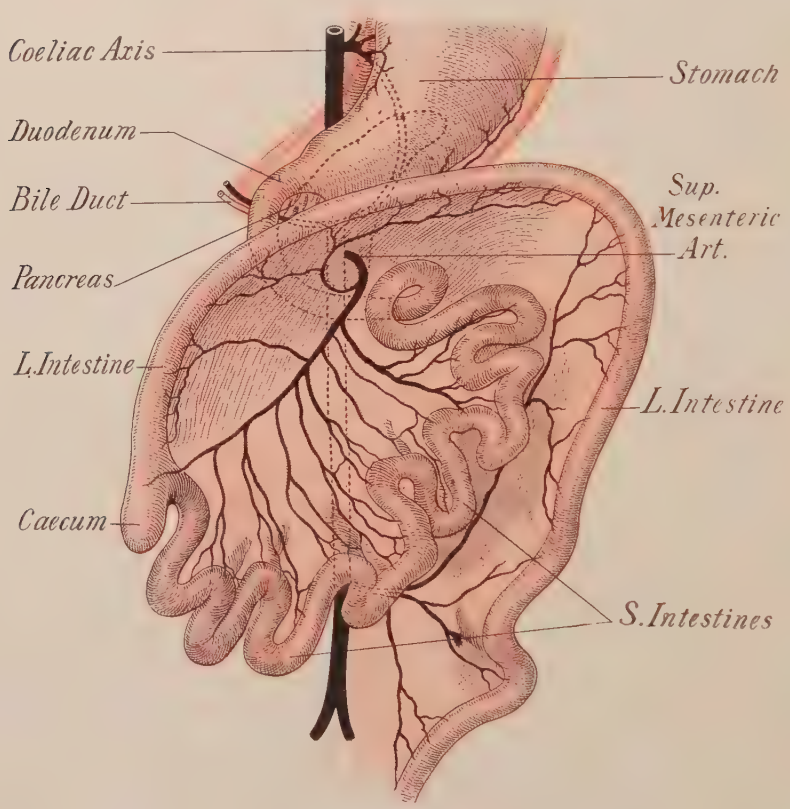

Fig. 4.—Diagram Representing Later Stage of Rotation of Abdominal Viscera.

(the upper limb of the U-shaped digestive tube) remains practically unchanged, while that of the large intestine assumes attachments corresponding to the ascending, the transverse and the descending mesocolon. At the same time that this intestinal rotation is taking place from left to right, the stomach likewise undergoes rotation in the same

direction, so that its left side becomes anterior, and its right side posterior in position. The liver passes to the right hypochondriac region, and the pancreas is shifted posteriorly and slightly to the left. The pyloric end of the stomach ascends, and the greater curvature becomes the inferior border, while the lesser curvature becomes the superior border of the stomach. The stomach has now therefore an anterior and a posterior wall, both covered with peritoneum; but whereas the anterior is in free communication with the general cavity of the peritoneum, the posterior wall has become more or less isolated, and is in relation with the pancreas, the lesser peritoneal cavity separating them. This lesser peritoneal cavity retains its only connection with the general peritoneal cavity at its right extremity through the foramen of Winslow. Above the stomach the gastro-hepatic omentum stretches from its lesser curvature to the liver, while from its greater curvature the great omentum passes downward between the stomach and the transverse colon, at first consisting of two double folds of peritoneum. Later these double folds fuse and become adherent to the transverse colon, so that the adult type is found shortly after birth. The duodenum and the pancreas are by this process of rotation sequestrated behind the stomach and transverse colon, and being subject to no movement of any consequence lose their posterior mesenteries by absorption, and become in extrauterine life retroperitoneal organs. It is a law that when two serous surfaces are approximated, and little or no motion exists between them, they fuse. Thus, the duodenum and its mesentery, in which the outgrowth of the pancreas developes, are pressed by the transverse colon against the posterior abdominal wall, and unite extensively with the peritoneum covering the latter. Growing apace with the gut at its intestinal attachment, the mesentery of the small intestine is thrown into fan-shaped folds, since at its vertebral attachment it remains short. Carried by the colon transversely across the end of the duodenum, the transverse mesocolon obtains secondary attachment to the latter and to the posterior abdominal wall, in a line from left to right, and remains permanently as a well-marked mesentery. Thus, the transverse colon with its mesocolon divides the abdominal cavity into an upper part that includes stomach, liver, duo-

denum and pancreas, and a lower which contains the small intestine. The mesenteries of the ascending and descending colon become obliterated by fusing with the parietal peritoneum of the posterior abdominal wall, so that in the mature condition these parts of the gut are, as a rule, covered by peritoneum only in front and at the sides.

The developement of the great omentum begins in the third month. Starting at the greater curvature of the stomach, it extends gradually downward, thus overlying in the first instance the transverse colon, and then the small intestine. Coming in contact in the first part of its course with the transverse mesocolon the great omentum soon fuses with this and with the transverse colon, and this relation becomes permanent. The pancreas, at first situated between the two layers of the mesogastrium, now acquires its retroperitoneal position.

Topographical Anatomy.—Stomach.—In adult life the stomach is almost entirely intraperitoneal. It retains its primitive mesentery from its greater curvature in the form of the gastro-colic omentum; while the mesentery acquired for it by the growth of the liver, attached to the lesser curvature, is known as the gastro-hepatic omentum. The greater and lesser curvatures of the stomach are thus extraperitoneal, and contain the main *blood vessels*. Along the lesser curvature run from left to right the gastric or coronary artery, from the cœliac axis, and from right to left the pyloric artery, from the hepatic artery, itself a branch of the cœliac axis. Along the greater curvature of the stomach runs from left to right the gastro-epiploica sinistra, from the splenic, and from right to left the gastro-epiploica dextra, from the hepatic through the gastro-duodenal. The anastomosis of both pairs of arteries is very free, and when divided at any part of their course severe hemorrhage from both ends is to be anticipated. Smaller branches are given off at right angles, which run transversely across the walls of the stomach. The branches from the lesser curvature supply about two-thirds of the areas on the anterior and posterior gastric walls. The veins correspond to the arteries, and ultimately empty into the portal vein.

Except for these omental regions the only *extraperitoneal* portion of the stomach is a small and irregular triangular area on its posterior surface near the cardiac opening. One angle of this triangle is at the

point where the coronary artery reaches the stomach (the gastro-phrenic ligament), a second is at the commencement of the gastro-splenic portion of the great omentum, while the third is to the left of and below the cardiac opening of the stomach.

The *lymphatics* of the stomach are of considerable importance in connection with the metastasis of malignant growths, and have only within recent years received adequate attention. As pointed out by Cunéo, who has studied the spread of malignant gastric neoplasms along the lymphatics, the stomach may be divided roughly into three lymphatic areas: one, in the region of the fundus of the stomach, where the nodes are few, and two others, along the greater and lesser curvatures respectively. Of these latter two areas, the nodes along the lesser curvature are much more apt to be involved in malignant growths, the area affected extending as far toward the œsophageal end of the stomach as the position of the coronary artery; while the duodenum is rarely involved (Carle and Fantino) for a distance of more than two or three centimetres. The nodes along the greater curvature do not enlarge so soon as do those along the lesser. The practical deductions from these facts will be considered in greater detail when discussing malignant growths of the stomach. From these various lymphatic nodes the lymph vessels pass to the cœliac nodes; the vessels from the lesser curvature following the course of the coronary artery, and those from the greater curvature running with the right gastro-epiploic vessels, both sets eventually meeting in the same nodes (cœliac) around the aorta, above the origin of the superior mesenteric artery. Jamieson and Dobson have recently made a study of the lymphatics of the stomach. They found nodes beneath the pylorus quite frequently present, draining the neighbouring portion of the greater curvature. In not a few instances they were able to trace lymph channels from the pylorus directly past the lower coronary group of glands into the

Fig. 5.—Lymphatic Areas of the Stomach.

right suprapancreatic glands lying along the trunk of the hepatic artery.

The stomach is supplied liberally by sympathetic *nerves*, as well as by the terminal filaments of the pneumogastric. The left pneumogastric curves around to the anterior border of the œsophagus, just above the cardiac orifice of the stomach, and distributes branches to the lesser curvature and anterior wall of the stomach; while the right pneumogastric is similarly distributed over the posterior wall. Fila-

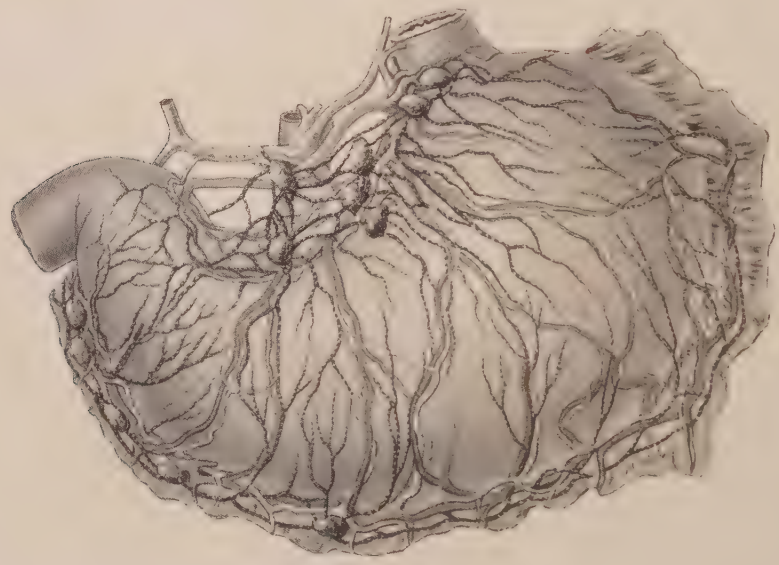

Fig. 6.—Semi-diagrammatic Drawing of the Arteries, Veins, and Lymphatics of the Stomach.

ments from both nerves inosculate along the greater curvature. Some filaments from the right nerve pass to the left side of the cœliac and splenic plexuses of the sympathetic system, while some of the filaments from the left nerve pass from the lesser curvature of the stomach through the gastro-hepatic omentum to the hepatic plexus. The free nerve supply of the stomach is largely responsible for the great pain experienced in ulcerations and adhesions of this viscus.

The posterior wall of the stomach cannot be satisfactorily palpated

through the foramen of Winslow; as a rule only the posterior surface of the pylorus is thus reached. In the free fold of the gastro-hepatic omentum may be felt the common bile duct, furthest forward, and further in and to the patient's left the hepatic artery, with the portal vein behind and between. The duct of Wirsung (pancreatic) is too short and too low down to be palpated without loosening the layer of

Fig. 7.—Probe in Foramen of Winslow.
The liver has been drawn upward to expose the gastro-hepatic omentum.

peritoneum covering the right side of the descending duodenum. To expose thoroughly the posterior wall of the stomach we have a choice of two routes—through the gastro-colic omentum, or through the transverse mesocolon. As a rule the latter is to be preferred, because it is in most cases the proper route for the performance of gastro-jejunostomy, but because the gastro-colic omentum may be more widely

opened this is the route to be selected in emergencies. The incision in the transverse mesocolon should be antero-posterior, so as to avoid the middle colic artery and its branches. Where, however, it is merely desired to explore the posterior wall of the stomach, gastro-enterostomy not being contemplated, and where the gastro-colic omentum is sufficiently wide to permit, this may be divided, close to

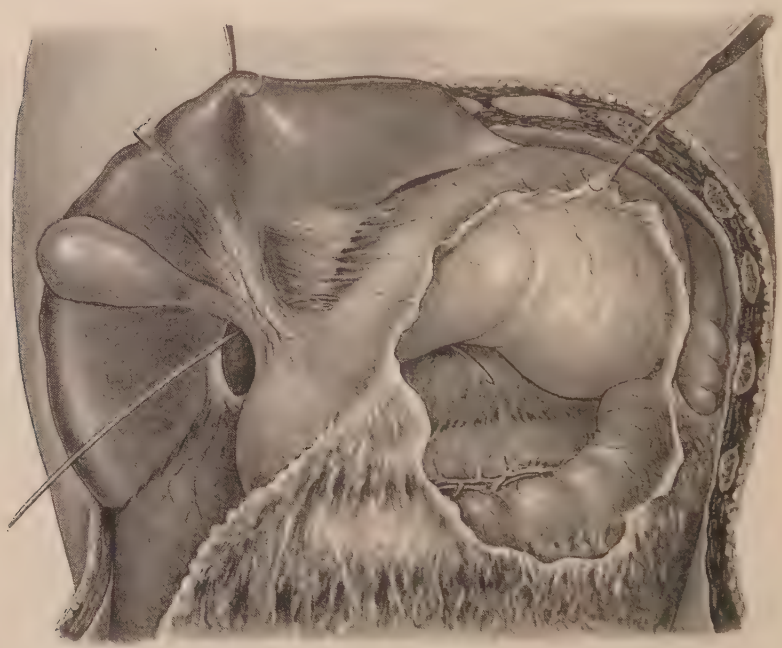

Fig. 8.—Structures in the Lesser Peritoneal Cavity Exposed by Dividing the Gastro-colic Omentum.

the colon, so as to avoid the gastro-epiploic arteries, and the stomach partially inverted through the opening.

The cardiac orifice of the stomach is directed almost horizontally, so that the surgeon's finger, seeking entrance to the œsophagus from within the stomach must be passed toward the patient's right. The body of the stomach is divided into the fundus and the pyloric antrum by a sphincter-like band of muscle (sphincter of the antrum pylori)

which encircles the stomach at a variable distance from the pylorus. A line dropped vertically from the cardiac orifice will usually represent the approximate position of this sphincter. The musculature of the pyloric antrum is much more developed than is that of the fundus of the stomach, a fact which is explained by the motor functions of the stomach during digestion (p. 47). When tonic contraction of the pyloric antrum exists, the surgeon may be deceived at operation into thinking the case one of hour glass stomach, so distorted does the outline of the stomach appear.

Liver.—The liver presents several *extraperitoneal areas*. The largest is on the postero-superior surface of the right lobe, between the layers of the right portion of the coronary ligament. Here, about the middle of the posterior surface of the liver, the inferior vena cava is found. The extraperitoneal area between the layers of the median and left portions of the coronary ligament is insignificant in size, as is also that region about the transverse fissure where the bile duct, the portal vein and the hepatic artery are found. For practical purposes, therefore, the liver is wholly an intraperitoneal organ; although abscesses pointing through its superior surface are usually excluded from the general peritoneal cavity by adhesions.

When the hand is introduced between the right lobe of the liver and the diaphragm through an abdominal incision, it passes backward over the upper convex surface of the liver for about six inches, when the finger tips are arrested by the coronary ligament, running transversely across the surface of the liver. The falciform ligament will be felt running forward from the coronary ligament, close to the median line of the body, and will prevent the fingers from passing from the surface of the right lobe across to that of the left. By carrying the hand well along to the right edge of the liver, the right extremity of the coronary ligament, known as the right lateral ligament, will be felt, and in some cases the fingers can be passed around the free margin of this ligament on to the posterior surface of the liver, back of the posterior layer of the coronary ligament. The hand is here arrested by the reflection of the visceral peritoneum on to the posterior abdominal parietes. On the left side of the falciform ligament, above the left lobe of the liver, the left coronary ligament, and

its extreme portion, the left lateral ligament, may likewise be palpated by the examining hand.

The under surface of the liver is also quite easily examined by the

Fig. 9.—Sagittal Section through Upper Abdomen, Passing through Gall-Bladder and Descending Duodenum. To show Reflection of Peritoneum. —(*After Bardeleben.*)

sense of touch. At the cartilage of the right ninth rib, a couple of inches to the right of the falciform ligament, held close against the under surface of the liver by a fold of peritoneum, is the gall-bladder,

and by following this landmark backward with the fingers, we are led first to the cystic duct, then across the anterior margin of the foramen of Winslow along the common bile duct in the free margin of the gastro-hepatic omentum, to the posterior surface of the pylorus. Beyond this point the duct usually cannot be palpated, as it becomes retroperitoneal behind the descending part of the duodenum. To the right of the gall bladder the hand will pass beneath the right lobe of the liver and above the transverse mesocolon and the upper pole of the right kidney, as far as the posterior abdominal wall (twelfth rib); and in some cases slightly upward on the posterior surface of the liver, before meeting with the inferior reflection of peritoneum which forms the posterior layer of the right coronary ligament. Close to the spinal column the ascending vena cava can be palpated. Passing the hand to the left of the gall bladder, along the inferior surface of the left lobe of the liver, the fingers are arrested within a few inches by the attachment of the gastro-hepatic omentum along the transverse fissure of the liver. This fissure is limited on the right by the neck of the gall bladder and the cystic duct, and on the left by the round ligament within the folds of the falciform ligament attached to the longitudinal fissure of the liver. By now passing the hand further to the left, the left extremity of the gastro-hepatic omentum is reached, enclosing the œsophagus, and the hand can be pushed backward between the cardiac end of the stomach below and the left lobe of the liver above until the inferior layer of the left lateral ligament is encountered, at the posterior surface of the left lobe. The Spigelian lobe may be palpated by passing the finger through the foramen of Winslow, and then upward between the spinal column (tenth and eleventh dorsal vertebræ covered by the diaphragm) and the liver. The surface of the liver so reached is the Spigelian lobe. It is wholly within the lesser peritoneal sac. Its right boundary is formed by the inferior vena cava, its left by the œsophagus and cardia of the stomach, its upper boundary by the coronary ligament of the liver, and its lower by the transverse fissure of the liver (attachment of the gastro-hepatic omentum). As the finger lies in the foramen of Winslow that portion of the liver immediately above it is the caudate lobe, connecting the Spigelian to the right lobe.

The gall bladder, which has already been mentioned, deserves further notice. Being formed as an outgrowth from the duodenum along with the liver, it grows forward beneath this organ, and is enveloped in peritoneum except along its hepatic surface. Often a fold of peritoneum passes nearly directly downward from the fundus of the gall-bladder to the hepatic flexure of the colon (cystico-colic liga-

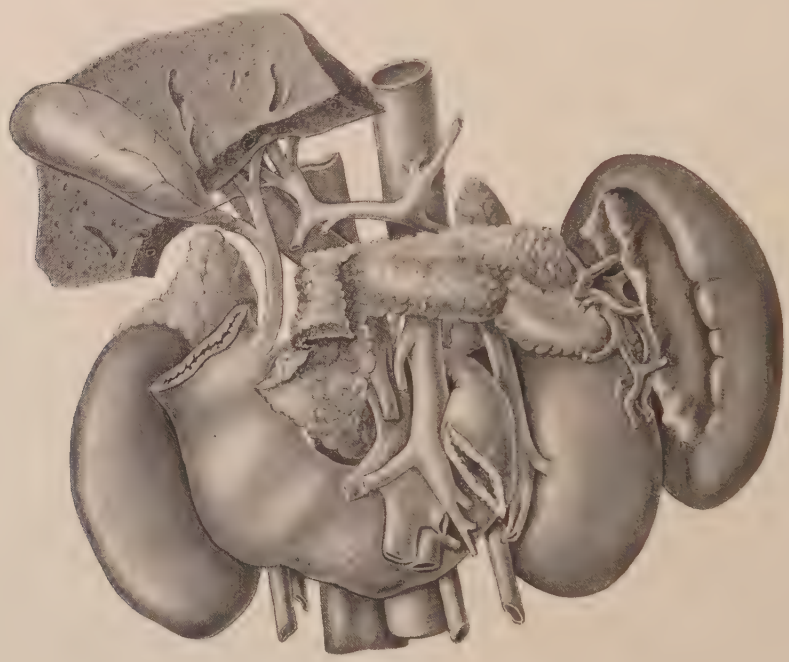

Fig. 10.—The Bile Ducts and Their Relation to the Duodenum and Pancreas.

ment), but more frequently the peritoneum covers the under surface of the gall bladder closely, and passes thence to the duodenum. These peritoneal folds have been particularly studied by Sencert. The vestibule of the foramen of Winslow is the space between the hepatocolic ligament posteriorly and the cystico-colic ligament anteriorly. Just to the left of the foramen of Winslow is the *atrium bursæ omentalis*.

The cystic duct is from one to two and a half inches (2.5 to 6.5 cm.)

in length, and joins the hepatic duct at an acute angle, to form the common bile duct. The cystic duct is about one-tenth of an inch (2.5 mm.) in diameter. The hepatic duct is usually only one to one and a half inches (2.5 to 4 cm.) in length, and is formed by the coalescence of the right and left bile ducts descending from the liver. Its diameter is one-sixth or one-quarter of an inch (4 to 6 mm.). The common bile duct is from one to three inches (2.5 to 7 cm.) or more in

Fig. 11.—Interior of Stomach, Pylorus, and Duodenum, Showing Papilla of Vater, also Orifice of Duct of Santorini.

length, compensating for the shortness of the other ducts when they are of less than average length. It is about one-quarter of an inch (6 mm.) in diameter. It ordinarily commences a little above the upper level of the pylorus, and passes down behind this and the descending duodenum in front of the pancreas, until it is joined on its posterior side by the pancreatic duct. As it passes downward it may be completely enclosed in pancreatic tissue. The combined pan-

creatic and bile ducts then traverse the posterior duodenal wall obliquely for about three-fourths of an inch, and empty into the interior of the descending duodenum about three or four inches (7 to 10 cm.) beyond the pylorus. To obtain a good view of this opening it is necessary to open the anterior duodenal wall, when the orifice of these ducts will be perceived as a slight projection of the mucous membrane (papilla of Vater) guarded on its superior surface by a further fold or hood of mucous membrane, which is provided with a frænum. Other similar folds are sometimes found surrounding the papilla of Vater on all sides. Gall stones not infrequently lodge in the dilated portion of the duct known as the ampulla of Vater, just outside the duodenal opening.

The *arterial supply* of the liver is conveyed to it almost entirely through the hepatic artery, a branch of the cœliac axis. By a somewhat semicircular course, with the convexity forward, this artery passes across the inferior border of the foramen of Winslow to reach the upper border of the pylorus, where it enters the gastro-hepatic omentum, holding here a position to the left and in front of the portal vein, which lies behind and between the hepatic artery and the bile duct. Its length is from one and a half to two inches (4 to 5 cm.) and in diameter it is not far from a quarter of an inch (6 mm.). On reaching the transverse fissure of the liver the hepatic artery divides into two branches: of these, the right passes obliquely to the right, usually behind, but occasionally in front of, the bile ducts, and gives off the cystic artery to the gall-bladder. The cystic artery lies between the cystic and hepatic ducts, and on reaching the neck of the gall-bladder divides into a superior and an inferior branch, which supply the corresponding surfaces of the gall-bladder. The left hepatic artery, which is shorter than the right, passes to the left extremity of the transverse fissure, and supplies branches to the Spigelian and left lobes of the liver.

The *veins* of the liver collect the blood within its lobules, and, by radicles of gradually increasing size, finally empty by two or three trunks directly from its posterior surface into the inferior vena cava. Except for semilunar folds at the entrance of these veins into the vena cava, no valves exist throughout the hepatic veins. The blood is

urged onward largely by the alternate contraction and expansion of the liver which occurs during respiration.

The *portal vein*, as is well known, is formed in front of the body of the first lumbar vertebra by the junction of the superior mesenteric and splenic veins. At its origin it lies between the head of the pancreas in front and the inferior vena cava behind. Then passing behind the pylorus and first part of the duodenum, it enters the folds of the gastro-hepatic omentum, lying behind and between the hepatic artery on the left and the bile duct on the right. In the connective tissue which surrounds it lie numerous filaments of the hepatic plexus of the sympathetic nerve, as well as some efferent lymphatics from the liver. On reaching the transverse fissure, the portal vein divides into two branches, right and left, distributed to the corresponding lobes of the liver. The main trunk is about three or four inches (7 to 10 cm.) in length. The portal system of veins drains the stomach, the whole of the small intestine, the vermiform appendix, the cæcum, the ascending, the transverse, and most of the descending colon, as well as the spleen and the pancreas. The cystic vein of the gall-bladder also empties into the portal vein.

There are certain definite connections between the portal vein and the systemic veins, which are of importance in various hepatic conditions. These connections may be classified as (1) those within the falciform ligament of the liver, namely, a small vein which sometimes is present, as the remains of the umbilical vein, and other small veins, known as para-umbilical veins, which surround the round ligament of the liver and anastomose with the epigastric and mammary veins of the abdominal wall; (2) anastomoses between various radicles of the portal system and veins of the posterior abdominal wall—as between those of the pancreas, of the duodenum, and of the ascending colon, with veins of the posterior abdominal wall, such as the lumbar veins, the azygos veins, etc.; (3) between the superior hemorrhoidal veins (tributaries of the portal) and the middle and inferior hemorrhoidal veins (tributaries of the internal iliac veins); (4) certain anastomoses between the tributaries of the coronary veins and the œsophageal veins; and (5) between the veins of the portal system and the phrenics, at the uncovered area of the liver. Of these various communications

the most important are the first, third and fourth classes, especially the third and fourth. Portal obstruction may produce the "caput Medusæ" around the umbilicus in affecting the veins of the falciform ligament; in this case the current of blood flows away from the umbilicus and the para-umbilical veins. But if the "caput Medusæ" is due to obstruction of the inferior vena cava, then the course of the blood is reversed, and it drains toward the navel into the veins of the round ligament. In such cases there is also sometimes enlargement of a superficial vein connecting the epigastric or external iliac vein with the axillary, which is easily detected as it runs up the side of the abdomen and chest. Enlargement of veins in the second classification is seen chiefly where the pancreas, duodenum, etc., are bound down by adhesions, and their normal drainage into the portal system is interfered with. Hemorrhoids, one of the most annoying and constant symptoms of portal obstruction, are produced by overdistention of the superior rectal veins; and as the communication between them and the middle and inferior hemorrhoidal veins is free, all three sets of rectal veins are frequently found to be varicose. The importance of varicose veins of the œsophagus as a symptom of portal obstruction has been particularly insisted upon by David Riesman of this city; and we have knowledge of more than one patient who has bled to death from the rupture of unsuspected varicose œsophageal veins. The case reported by W. J. Taylor will be again referred to.

The *lymphatics* of the liver are divided into internal and external. The former accompany the branches of the hepatic and portal veins, and are not of so great surgical importance as the external set. Those accompanying the hepatic veins empty into the lymph nodes situated on the upper surface of the diaphragm just above the caval opening; while the lymph vessels accompanying the portal veins empty into the nodes about the neck of the gall-bladder and the cystic duct. The external lymphatics of the liver lie under its peritoneal covering, and in the connective tissue of the capsule of Glisson, and all drain away from the interior of the liver. They consist of several groups: (1) Those on the upper or convex surface: (a) Three or four branches pass forward along the upper surface of the liver into the falciform ligament, where they unite into a single trunk which enters the chest

through the small diaphragmatic opening at the side of the xiphoid cartilage, and joins the anterior mediastinal nodes, eventually emptying into the right lymphatic duct. (b) A similar group turns downward over the anterior border of the liver to its under surface, passes along the longitudinal fissure to the transverse fissure, and thence to the nodes of the gastro-hepatic omentum. (c) Some lymphatics from the superior surface of the right and left lobes of the liver pass to the right and left lateral ligaments, and enter the anterior mediastinal nodes or the lower end of the thoracic duct. (2) The external lymphatics from the under surface of the liver may be classified as follows: (a) Those on the right of the gall-bladder empty into the lumbar nodes; (b) those on the left of the gall-bladder pass to the œsophageal nodes and to the nodes along the lesser curvature of the stomach; and (c) those surrounding the gall-bladder form a plexus and pass to the nodes of the gastro-hepatic omentum. It is thus seen that the lymph nodes around the neck of the gall-bladder and in the gastro-hepatic omentum drain the following areas of the liver: anterior median portion of the convex surface, gall-bladder area, and all of the inferior surface of the left lobe; as well as receive the deep lymphatics which run with the branches of the portal vein. These nodes, therefore, in the gastro-hepatic omentum are the most important surgically of all the lymph nodes in connection with the liver, and are frequently found enlarged in gall-bladder diseases, in malignant growths, and in inflammations of the liver, as well as in hepatic cirrhosis. They are also sometimes enlarged in Hodgkin's disease, and by compression of the portal vein have been said to cause ascites in this affection; but this latter action has been questioned. As Rolleston has pointed out, neoplasms occasionally work their way into the liver by the portal fissure against the lymph stream which normally flows outward in this location.

The *nerve supply* of the liver is derived from the hepatic plexus of sympathetic nerves, which receives filaments from the left pneumogastric and the right phrenic nerves. This plexus accompanies the ramifications of the hepatic artery through the liver substance, and sends branch plexuses along the pyloric and gastro-epiploic arteries. A cystic branch for the gall-bladder is also derived from the hepatic

plexus. The right phrenic nerve is derived mainly from the fourth cervical nerve, which also sends a branch—the supra-acromial nerve—to the integument of the point of the shoulder, thus explaining the "shoulder-tip pains" encountered in certain hepatic affections.

The disposition of the peritoneum and the relations of neighbouring organs to the liver form what has been well described by M. H. Richardson as the "liver pouch." This is of vast importance in preventing infection of the general peritoneal cavity in diseases of the gall bladder and other organs in the upper right abdominal quadrant. Limited by the under surface of the right lobe of the liver above, by the duodenum and spinal column toward the median line, and by the transverse mesocolon below, this pouch readily collects all extravasated fluids and becomes a valuable site for drainage, which may in some instances be most readily procured by an incision into its floor from the loin, below the inferior pole of the kidney.

Duodenum.—The duodenum, with the exception of its first portion, is entirely retroperitoneal, and is covered in front by so many important structures that only its first and second portions are readily accessible during life. The first portion, continuous with the pylorus, is easily reached above the transverse colon, and to the left of the gall ducts. The descending portion is best exposed by dividing the outer layer of the ascending mesocolon throughout its upper third, when by rolling the ascending mesocolon together with the pylorus toward the patient's left, the outer and posterior walls of this portion of the duodenum will come into view; the bile and pancreatic ducts are thus accessible to surgical treatment. To expose the transverse portion of the duodenum the least dangerous plan is to divide the inferior layer of the mesentery of the small intestine, just above the bifurcation of the aorta; this gives access to the duodenum as it crosses the spinal column immediately below the superior mesenteric vessels. In Jaboulay's entero-anastomosis (p. 368) the transverse portion of the duodenum on the right of the superior mesenteric artery is utilized. The duodeno-jejunal flexure is readily found by turning the transverse colon upward and seeking for the origin of the jejunum as the small intestine emerges from beneath the transverse mesocolon. Below and to the left of the terminal portion of the duodenum, with its orifice

FIG. 12.—THE ORIGIN OF THE JEJUNUM, AND THE DUODENO-JEJUNAL FOSSA, EXPOSED BY TURNING THE TRANSVERSE COLON UPWARD.

directed upward, is the duodeno-jejunal fossa. It is found in about 48 per cent. of cases, and may be the seat of retroperitoneal hernia.

The relations of the duodenum to surrounding organs have already been considered. Of these the most important are its relations with the gall bladder and with the transverse colon. From the former it is separated by two serous surfaces, the visceral layer covering its first and second portions, and the visceral layer of the gall bladder itself. In spite of this fact adhesions are frequent, and ulceration of the duodenum may extend into the gall bladder, or vice versa. From the transverse colon the descending duodenum is separated only by a little areolar tissue, there being no peritoneum between the two organs where the root of the transverse mesocolon crosses the duodenum. The duodenum is fixed in its position not only by its retroperitoneal situation, but by peritoneal reflections to the liver and gall bladder from its initial portion, and by the ligament of Treitz from the duodeno-jejunal juncture to the diaphragm. Besides these means of fixation, there are the insertion of the bile and pancreatic ducts, and the proximity of the superior mesenteric vessels in front and above the duodenum.

Ochsner has described a sphincter of the duodenum, consisting of a more or less well defined band of thickened circular fibres, usually some distance below the entrance of the bile and pancreatic ducts. He thinks it is of assistance in the phase of duodenal digestion by retaining the chyme in the duodenum until it is ready to be discharged into the jejunum. Boothby has been unable to confirm the existence of such a sphincter in any of 25 specimens examined at autopsy.

Pancreas.—The pancreas, which is also retroperitoneal, is covered anteriorly by the posterior parietal layer of peritoneum which forms the lesser peritoneal cavity. It is best exposed through the gastro-colic omentum, or through the transverse meso-colon. The latter route gives access only to the body and tail, since the middle colic artery would have to be divided to expose the head. The posterior portion of the head is, however, partially exposed by the same means advised for the exposure of the descending duodenum, and pancreatic and bile ducts. But by dividing the gastro-colic omentum close to the colon, leaving the gastro-epiploic vessels attached to the

greater curvature of the stomach, and then dividing, within the lesser peritoneal cavity, the superior layer of the transverse mesocolon over the pancreas, a fairly free exposure of this organ throughout its whole length is obtained.

The *blood supply* of the pancreas is derived chiefly from the pancreatic branches of the splenic. This artery runs in a very tortuous course along the upper border of the pancreas. Situated just between the cœliac axis above and the superior mesenteric vessels below, injuries of the pancreas are almost invariably fatal from hemorrhage

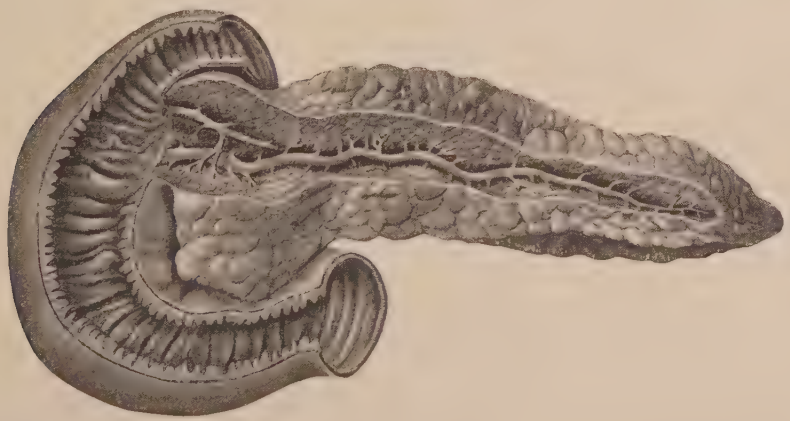

Fig. 13.—The Pancreas, its Ducts, and Their Relation to the Duodenum.

if not by sepsis or lack of nutrition. The close relation borne by the pancreas to the posterior wall of the stomach explains the frequency with which this organ is involved in carcinoma of the stomach. Primary carcinoma may also affect the pancreas, and the growth, if it involves the head of the organ, may cause occlusion of the common bile duct and consequent jaundice. If the malignant growth affects that part of the organ in relation with the aorta, it may simulate aortic aneurism by causing a swelling over which transmitted pulsation is detected.

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CHAPTER II.

PHYSIOLOGY OF DIGESTION.

The region of the upper abdomen includes practically all of that portion of the intestinal tract, with its annexed glands, concerned in the process of digestion. Although the intestines below the duodenum serve as a receptacle for the ingested food, and although the succus entericus has certain important functions to perform upon the ingesta, yet these parts of the digestive tube are concerned more particularly in the processes of absorption and elimination than in that of digestion.

No less striking than the developement of the surgery of the abdomen during the last decade, are the valuable contributions to our knowledge of the physiology of digestion which are products of the same period. There is no better illustration of the fact that the solution of physiological problems, which has baffled master minds of bygone days, has been rendered possible only by the employment of modern surgical methods in investigations, than the fact that the observations of Beaumont upon Alexis St. Martin, who had a gastric fistula caused by a gunshot wound, have been considered authoritative from 1825 until recent times. The results of modern investigation have such important clinical relations to the surgery of the digestive system that they well merit consideration here.

Intricate though the processes of digestion may seem at first sight, yet a knowledge of embryology renders these problems simple.[1]

Perusal of the preceding chapter has revealed the fact that, in the fœtus, the alimentary canal early assumes the form of a straight tube. A portion of this tube becomes dilated, and forms the stomach. New

[1] As W. J. Mayo expresses it, man prepares his food with the organs which have their origin in the foregut, and absorbs his nutrition from the derivatives of the midgut; that is, he eats with the jejunum and the ileum and drinks with the cæcum.

relations are established by rotation of the stomach and intestines. Evaginations of the wall of the duodenum create two essential glands, —the liver and the pancreas. Analysis of this growth-process impresses one at the outset with two striking features: first, the very early appearance of the rudiments of the liver and pancreas, and secondly, the great extent of intestinal coiling. The first feature suggests directly that glandular activity is to be closely associated with the workings of the digestive tube. As a matter of fact, the latter is lined from the lips to the anus with countless glands. The developement of any gland is very simple, but specialization occasions complexity. Cylindrical ingrowth of the epithelium (which in this case lines a cavity) into underlying tissue, with subsequent hollowing-out of the cylinders, constitutes a gland of the simple unbranched tubular type, such as is present in the fundus of the stomach, or, as Lieberkühn's glands, throughout the small and large intestines. Offshoots from the cylinders establish the type of simple branched tubular glands, represented by the countless small serous and mucous glands of the oral cavity, and by the glands at the pylorus of the stomach and in the duodenum (Brunner's glands). If the endings of the epithelial plugs expand and secondarily give rise to primary alveoli, there is produced the racemose type of glands, such as the salivary glands and pancreas. Further and more complicated modifications of structure produce a reticular tubular gland, such as the liver, in which instance the anastomosis between the branches of the tubular glands is so extensive that a net-like structure is produced. The salivary glands, pancreas, and liver are distinguished by ducts of various lengths, so that we may designate them extra-mural glands. To sum up, therefore, we are impressed with the fact that innumerable glands line the digestive tube, and that, where the requirements of the organism demand it, several glands are further developed and specialized, and are removed from the walls of the digestive tube to undergo further enlargement, but are still connected with this tube by ducts of varying lengths. The aggregate of output of these glands is, therefore, very considerable. Sappey has calculated that the surface of the mucous membrane of the human stomach presents over 5,000,000 orifices of gastric glands.

Digestion may be defined as a mechanical and chemical process

by which food is prepared for absorption. Of course it is useless, in a work which aims to treat of practical questions in the surgery of the upper abdomen, to discuss at length the various theories and facts involved in the study of human digestion; but it is unavoidable to offer readers of such a work some sort of reference chapter, which will serve to illustrate the main principles of physiology involved, and will enable them to orientate their knowledge when discussing the pathology and treatment.

Digestion means the intake of food, its mastication, its exposure to the action of various secretions, to intestinal movements, to absorption, and finally, if of no further use to the organism, its elimination. Nature prepares a very difficult gauntlet for the food to run, so as to extract from it every possible iota of nutrition. Prolonged contact with the food is secured, in the first instance, by coiling of the small bowel, and sacculation of the large; and, secondarily, by the presence of the valvulæ conniventes and villi in the small intestine. Not only is the area of absorption incalculably increased in this way, but also the capacity of secretion is augmented manifold.

As regards function, practically all of the glands in connection with the gastro-intestinal tract are capable of secreting mucus, the lubricant. Some few secrete serous fluid, the diluent. To fewer still is reserved the property of secreting more highly specialized products, the enzymes. Two, the liver and pancreas, are concerned also in internal secretion.

Food stuffs, as we all know, are classed as Proteids, Carbohydrates, and Fats, respectively represented by meats, by sugars and starches (rice, macaroni, bread, etc.), and by fatty substances such as butter, eggs, cheese, and fat of meats. When digested and therefore prepared for absorption, it may be stated with sufficient accuracy that proteids become peptones, that carbohydrates become maltoses, and that fats are absorbed practically unchanged.

The proteid is acted upon by three agencies, namely, the pepsin of the stomach, the trypsin of the pancreas, and the bacteria in the large intestine. The carbohydrate constituent is disposed of by three agencies, the ptyalin of the parotid glands, the amylopsin of the pancreas, and amylolytic enzymes from Lieberkühn's glands of the small

intestine. The fats are attacked by the lipase (steapsin) of the pancreas, an enzyme the activity of which is enhanced by the bile. There are other less important enzymes.

The mechanical part of digestion is, or should be, performed largely by the cooking and by the mastication of the food before it ever reaches the stomach. After being swallowed, the action of the stomach consists both in a churning movement which mixes the bolus of food with the gastric juices, as well as in a rhythmic peristalsis by which the food is from time to time urged forward into the duodenum. Beyond the pylorus, practically the only mechanical action to which the ingesta are subjected, apart from the peristaltic motion of the intestines, is represented by the dilution which they undergo by admixture with the bile and with the pancreatic and intestinal juices. So great is this dilution that although much of the fluid portions of the food is absorbed while passing through the small intestine, yet even when the cæcum is reached the intestinal contents are always very soft, and usually semifluid.

From the standpoint of anthropology, cooking of foods is not essential to the welfare of mankind, but is a product of civilization. This trespass upon Nature has resulted in an inherited tendency of the human teeth toward premature decay on account of decreased necessity for the grinding action. The possession of poor teeth predisposes to gastro intestinal affections, whilst a good set acts as a powerful prophylactic. However, cooking of meat sets free the muscle fibres by its action on the connective-tissue, which it partly transforms into gelatin. Cooking of vegetables springs the pellicle and renders the starch more soluble. In bread baking, the dough is spongified by the carbonic acid formed from the yeast. Furthermore, cooking kills parasitic ova, and renders food sterile.

The **prephase of digestion** is initiated by the senses of sight, smell, and hearing, and also by the thought of, and longing for, food. Careful and attractive preparation of food, and savory odours that emanate from it, powerfully whet the appetite. Appetite is stimulated through the sense of hearing, by clatter of dishes and the sizzling of meat directly removed from the fire. The craving for food is instinctive, and is the basis of the appetite.

Salivary Digestion.—These psychic events bring about a flow of saliva, as a preparatory step to the introduction of food into the mouth. The presence of food in the mouth causes additional flow of saliva, which now is adapted to the character of the material ingested. The secretion from the parotid glands is serous, and contains the enzyme, ptyalin; that from the sublingual and numerous minute glands in the mouth is mucous, whilst the secretion of the submaxillary glands is mixed, serous and mucous. By moistening the food, saliva aids mastication, and by enveloping the hard and bulky bolus with mucin, it facilitates deglutition. It dissolves the soluble, a step necessary for inauguration of taste sensations. Furthermore, saliva is protective in that it tests materials introduced into the mouth, neutralizing deleterious properties, rejecting the harmful, and washing out injurious substances which might enter the blood through contact with the mucous membrane. A specific excitability is manifested by the salivary glands, since fresh, moist food creates but little secretion, whilst dry materials induce a copious flow. The amylase (ptyalin) from the parotid gland changes starch into dextrin and maltose. Owing to the short stay of food in the mouth, salivary digestion takes place chiefly in the stomach. Although destroyed by gastric juice, yet ptyalin continues its action in the interior of the bolus of food until the gastric juice has completely penetrated the mass, a process which requires from 20 to 40 minutes.

Gastric Digestion.—Before the food reaches the stomach, gastric juice has been secreted by the innumerable tubular glands which stud thickly the gastric mucosa. The excitant of this preliminary flow is psychic; in fact it resides in the appetite, and hence we may speak of "appetite-juice." The latter, which appears within 5 minutes, is copious in amount, and strong in digestive power. A good appetite in eating is equivalent from the outset to a vigorous secretion of the strongest juice; lacking appetite, this juice is also absent. Restoration of appetite means gastric juice in plenty, wherewith to inaugurate digestion. The gastric glands may be as active during sleep as in the waking hours.

The qualitative secretion of the gastric glands varies in different parts of the stomach. In the fundic region pepsin, rennin, and

scanty amounts of hydrochloric acid are secreted; in the pre-pyloric region the same substances and most of the hydrochloric acid, the latter fact being indicated by the deeper red color of the mucous membrane in this area; whilst in the pyloric region pepsin and rennin only are produced.

In the stomach the ingesta undergo equalization of temperature, maceration by the gastric juice, and conversion into chyme. Although ptyalin is destroyed in an acid medium, yet salivary digestion of carbohydrates may proceed for 30 minutes in the stomach, not only on account of the slight acidity of the gastric juice in the fundus where the food first lodges, but also because of the length of time required for complete penetration of each bolus of food by the gastric juice. The copious amount of "appetite-juice" is now augmented by a second quantity of juice, produced chemically. The first complement of juice decreases in amount as the second increases. The latter depends on the production in the pyloric mucous membrane of a specific substance or hormone, which acts as a chemical messenger to all parts of the stomach, being absorbed into the blood and thence exciting the activity of the various secreting cells in the gastric glands.

Just as the acidity of the gastric juice, which is equivalent to 0.48 per cent. hydrochloric acid,[1] is detrimental to the action of ptyalin, so is it essential for the action of the ferment, pepsin. During the time usually occupied by gastric digestion, namely, from 3 to 6 hours, proteids are prepared by the pepsin-hydrochloric acid for subsequent digestion by the enzyme, trypsin, in the small intestine. With this end in view, most of the proteid is converted in the stomach into its first products of hydration, namely, peptones and proteoses, in which state the proteids of the food are normally passed on into the duodenum, having been rendered more amenable to the action of trypsin. Therefore, disposal of proteids occurs in the cycle of peptic-tryptic digestion.

[1] Thus when a patient is reported as having a gastric acidity of 60, the statement signifies that the total acidity is above the normal; in other words that there is hyperchlorhydria. If, on the other hand, the total acidity is reported as 35 or 40, the acidity is clearly below the normal. The "free" acid of the gastric juice normally varies between 0.1 and 0.2 per cent.

Rennin possesses the specific action of curdling milk, which is brought about by the coagulation of caseinogen.

Fat undergoes no digestive change in the stomach. It is merely liquefied by the bodily heat, dissociated from other foods by the specific proteolytic action of the pepsin-hydrochloric acid, and mixed with the chyme in the form of a coarse emulsion. Fat inhibits the work of the gastric glands, both from a quantitative and from a qualitative point of view: hence the omission of fat other than in emulsion, from a corrective dietary. On the contrary, water and extracts of meat exert a stimulating effect upon the secretion of gastric juice.

Absorption from the stomach is very slight, although alcohol is absorbed readily, and certain soluble drugs may be.

Gastric digestion continues until the whole of the stomach contents is discharged from the pylorus as the semifluid chyme. After this event, the stomach enters upon a resting stage, during which its cavity is practically obliterated.

Intestinal Digestion.—The fluid chyme, on entering the duodenum, is subject at once to the influence of the secretions of 3 different sets of glands, namely: (1) The intestinal glands, including those characteristic of the duodenum, called Brunner's glands; (2) the pancreas; (3) the liver. The ducts of the two latter in man have a common opening into the duodenum, and there is a co-operation between all three juices for the production of the intestinal digestive fluid.

The flow of pancreatic juice is initiated chemically. The epithelial cells lining the gut contain a body—pro-secretin—which, under the influence of agents such as acids, undergoes hydrolysis with the splitting off of a new body, termed secretin. The latter, on absorption into the blood, acts as the chemical messenger (hormone) to the pancreatic cells. Sleep does not hinder pancreatic secretion.

The pancreatic juice is alkaline, a reaction that corresponds closely in degree to the acidity of the gastric juice. Aided by the bile and alkaline juice from the intestinal glands, the pancreatic juice neutralizes the acid chyme, with the result that a neutral fluid, in which the processes of intestinal digestion will go on, is produced in the duodenum.

Secretion of pancreatic juice starts shortly after entrance of food into the stomach, and rapidly reaches a maximum in from 2 to 4 hours, whilst by the seventh hour it has practically ceased. The character of the food modifies the composition of the secretion. The pancreatic juice when it reaches the duodenum contains three enzymes, of which trypsin is proteolytic; amylopsin, amylolytic; and steapsin, lipolytic. Secretion evoked by proteids abounds in trypsin; that by carbohydrates, in amylopsin; and that by fats, in steapsin.

If trypsin be proteolytic, the question would naturally arise, why should not this enzyme digest the intestinal mucosa? The answer is contradictory. Trypsin is not a secretion, but a resultant. The secretion is trypsinogen, a pro-enzyme, which is converted into trypsin by enterokinase, a product of the duodenum and jejunum. Therefore, until enterokinase trans-substantiates trypsinogen into trypsin by catalysis, no proteolysis is manifested.

Trypsin continues the transformation of proteids that was begun in the stomach. It also completes the cycle of peptic-tryptic digestion. Trypsin, however, acts more rapidly and powerfully than pepsin, and breaks up the proteid molecule more completely. Thus, the peptones and proteoses, prepared from proteids by the pepsin, and delivered by the stomach into the duodenum, are further split by trypsin into amido-acids.

Amylopsin acts upon starches in very much the same way as does ptyalin. The carbohydrates that have escaped the action of ptyalin are hydrolyzed in the duodenum, by amylopsin, into maltose and dextrin; and these, in turn, are converted into dextrose by the maltase of the succus entericus.

Steapsin, materially aided by bile, splits up neutral fats into glycerin and free fatty acids.

The Secretion of Bile.—Since bile reaches the duodenum through an orifice common to it and to the pancreatic juice, the inference naturally is drawn that these two fluids co-operate in their action, and that bile is of direct use in digestion. As a matter of fact, bile increases the action of steapsin two to three fold, and that of trypsin and amylopsin about two fold. Indeed, bile is of great value in digestion, and plays an important *rôle* in this process. Beginning

almost immediately after taking food, the secretion of bile attains its maximum with the pancreatic juice in the third hour, is regulated by the same laws that govern the flow of other digestive juices, and then rapidly declines. Thus, bile is produced by the same agent as pancreatic juice, namely, by secretin. Furthermore, bile flows as long as digestion lasts, but with definite fluctuations in quantity and quality, dependent upon the nature of the food.

The bile is being constantly formed in the liver, and, during the intervals of digestion, is stored up in the gall-bladder. Its pressure is not known accurately, but is believed to be always greater than that of the blood in the portal vein. In amount the bile varies from twenty to twenty-seven ounces (600 to 800 cc.) daily. It is propelled from the liver into the gall-bladder by the muscular contractions of the larger bile ducts; and is again ejected into the duodenum in spurts by contractions of the gall-bladder. Its descent from the liver is possibly aided by gravity and by the changes in the bulk of the liver produced by respiration, as well as by the *vis a tergo* of the more freshly formed bile. The contraction of the gall-bladder is usually believed to be produced by sensory stimulation of the mucous membrane of the stomach or duodenum through reflex nervous action. The presence of chyme in the duodenum causes, by means of secretin, a contraction of the gall bladder and a relaxation of the sphincter surrounding the duodenal orifice of the bile duct, with consequent ejection of bile. It is an interesting fact that even though almost the whole amount of bile excreted be diverted through a biliary fistula, so that scarcely any of it reaches the intestinal tract, yet nevertheless the individual so affected may continue to enjoy good health, showing conclusively that bile is much more of an excretion than a secretion.

To sum up, the chief duty of the bile is to facilitate the transition from gastric to intestinal digestion, since it enters the duodenum at a spot where the acid peptic digestion gives place to alkaline pancreatic digestion; it arrests the action of pepsin, which is mischievous to the enzymes of the pancreatic juice, and reënforces the enzymes of the latter, particularly by serving as a vehicle for the suspension and solution of the interacting fats, fatty acids, and steapsin.

Not only is bile important in digestion, but further, as an excretion,

it is the channel by which the disintegration-products of hæmoglobin are cast out from the organism.

Succus Entericus increases the activity of the pancreatic enzymes. Just as bile aids particularly the action of the pancreatic lipolytic enzyme, so does succus entericus augment the proteolytic. Hence, both of these secretions are adjuvants of the pancreatic juice. Secretin is also the producer of succus entericus.

Succus entericus is a secretory product of some of the glands of Lieberkühn. Collectively, these glands, as well as those of the stomach, may be considered as an enzyme-producing entity which, instead of being gathered together to form an extramural organ, such as the liver or pancreas, are distributed throughout the intestinal wall, thence to discharge secretion directly into the lumen of the intestine.

Succus entericus, distinctly alkaline in reaction owing to sodium carbonate, contains four or five enzymes that complete the digestion of food-stuffs begun in the stomach and duodenum, thus exercising a most important influence upon intestinal digestion. Of these enzymes two, enterokinase and erepsin, are concerned in proteolysis. Enterokinase, as has been seen, activates the proteolytic enzyme of the pancreatic juice, by converting the trypsinogen into trypsin. Erepsin supplements the work begun by trypsin, in that it causes further hydrolysis of peptones and proteoses.

Secretin, which initiates the secretion of bile, pancreatic juice, and succus entericus, is not an enzyme, but a definite chemical substance produced in the intestinal wall in a preliminary form, pro-secretin, which, influenced by acids, is converted to secretin. The latter is absorbed and carried to the glands, the secretion of which it evokes.

The remaining enzymes of succus entericus are concerned in the digestion of carbohydrates. They are maltase, invertase, and lactase, the last being present in young individuals and in those fed throughout life exclusively upon a milk diet. Maltase acts upon the products of the digestion of starches, namely, maltose and dextrin, converting them into dextrose. Invertase transforms cane-sugar into dextrose and levulose, whilst lactase changes milk-sugar into dextrose and galactose.

Absorption in the Intestines.—In consequence of all these changes, the three classes of food-stuffs are reduced to a soluble condition, and in solution are taken up by the cells lining the intestine. The products formed in digestion largely disappear between the duodenum and the ileocæcal valve. Carbohydrates are absorbed chiefly as simple sugars—monosaccharids. As dextrose, then, the sugars pass directly into the blood stream, by which they are distributed first to the liver and then to other organs of the body. In the liver the excess of sugar is removed from the blood and stored as glycogen. Alimentary glycosuria is a phenomenon arising from ingestion of larger amounts of carbohydrates than the liver can store up as glycogen, the excess being removed from the blood by the kidneys, and excreted in the urine. Any carbohydrates which escape absorption as sugar are apt to undergo acid fermentation from the action of the bacteria constantly present in the intestine.

Proteids, hydrolyzed during digestion into peptones and proteoses, or amido-acids, probably are absorbed as such, passing directly into the blood-vessels of the intestinal villi, and thence into the blood stream.

Fats are absorbed by the epithelial cells in the forms of fatty acids and glycerin, which, in turn, are immediately re-synthesized into insoluble neutral fats in the cells themselves. In the state of the fine emulsion—chyle—most of the fats reach the blood stream through the lacteals and thoracic duct. Absorption of split fats is considerably aided by the bile. Some of the fat reaches the liver by way of the blood stream, and undergoes accumulation in that organ. If an excess of fat were ingested, or if the flow of bile were decreased or stopped, a large percentage of fat would escape absorption and appear in the fæces.

The secretion of the large intestine is alkaline, and contains much mucus, but is itself devoid of enzymes, those that are present having been contributed and passed along by the small gut. Since absorption and digestion are not completed in the small intestine, they are continued in the large. Furthermore, the latter absorbs large quantities of water.

Bacterial Action.—The bacteria normally found in the intestinal tract are of considerable practical importance. At birth the digestive

tract is sterile, but as soon as unsterilized food is ingested there are found bacteria of various kinds, pre-eminently the colon bacillus. As has been shown by numerous observers, the emptier the intestinal tract is of food, the fewer will be the bacteria present. In the stomach, bacteria disappear with the food, and when the stomach has been entirely empty for some time, its cavity is practically sterile, owing to the antiseptic properties of the gastric juice. Certain bacteria, especially the Bacillus subtilis and the Proteus vulgaris, are believed to have a proteolytic action, and thus to aid the peptic digestion. The duodenum in its upper part is singularly free from bacteria, probably due also to the acid gastric juice; but as the small intestine is traversed

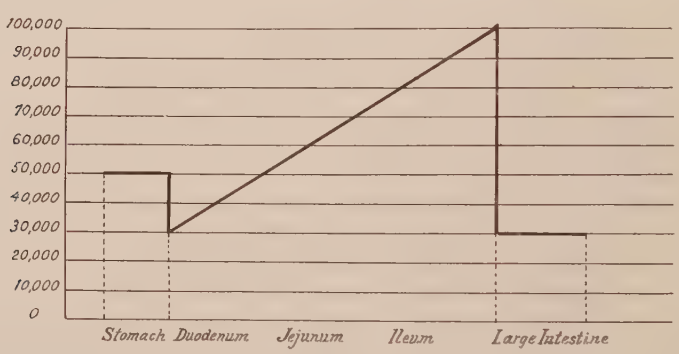

Fig. 14.—Graphic Representation of the Bacterial Content of the Gastro-intestinal Tract.

the bacterial content becomes greater and greater, reaching its maximum in the lower ileum; but when the acid secretions of the large intestine are reached, it falls again as low as it was in the duodenum. The annexed diagram from Gilbert and Domenici describes these changes much more accurately than can mere words. The practical application of these principles has been nowhere more successfully carried out in surgery than by Cushing at the Johns Hopkins Hospital. It is worthy of note that, just as purgation eliminates most of the bacteria with the intestinal contents, so prolonged constipation and especially intestinal obstruction markedly increases the virulence of the intestinal bacteria.

In the small intestine, bacteria show activity by fermenting carbohydrates. This process exerts a restraining effect upon proteid putrefaction, which, on the contrary, is a constant and normal occurrence in the large intestine. In this way proteids that have escaped digestion and absorption are split up into various end-products, some of which are given off in the fæces, whilst others are absorbed in part and excreted subsequently in the urine. The extent to which these bodies occur in the urine is an indication of the extent of putrefaction in the large intestine, a fact which possesses certain clinical value. Cellulose, for which there is no specific enzyme, is hydrolyzed by bacteria and thus rendered useful in nutrition. Aside from this, it may be said that bacterial fermentation is not essential for the welfare of the œconomy.

Composition of the Fæces.—The character of the food has an important influence upon the composition of the fæces. Upon a diet composed exclusively of meats they are small in amount and dark in colour; with an ordinary mixed diet the amount is increased; and it is largest with an exclusively vegetable diet, especially with vegetables containing a large amount of indigestible substances. Fæces are made up of indigestible and undigested materials; products of intestinal secretions and of bacterial decomposition; cholesterin, excretin, mucus and epithelial cells, pigment, inorganic salts, and microorganisms. In addition, gas, arising from bacterial fermentation of proteids, is present in varying amounts.

The main function of the alimentary tract, therefore, is the presentation to the tissues of the body of the food-stuffs in a form in which they are directly assimilable.

Liver.—Our knowledge of the physiology of the liver has, until recent years, consisted in acquaintance with the facts that it produced bile, and that it served as a storehouse for carbohydrates, absorbed as maltose and dextrose from the intestines through the portal system of veins, and stored up in the form of glycogen. This glycogen, by the metabolic action of the liver cells, may be again converted into maltose as occasion demands, and be given off into the general circulation for nutriment to the muscles and other structures of the body. Lately, however, attempts have been made by Silvestri and others to specialize

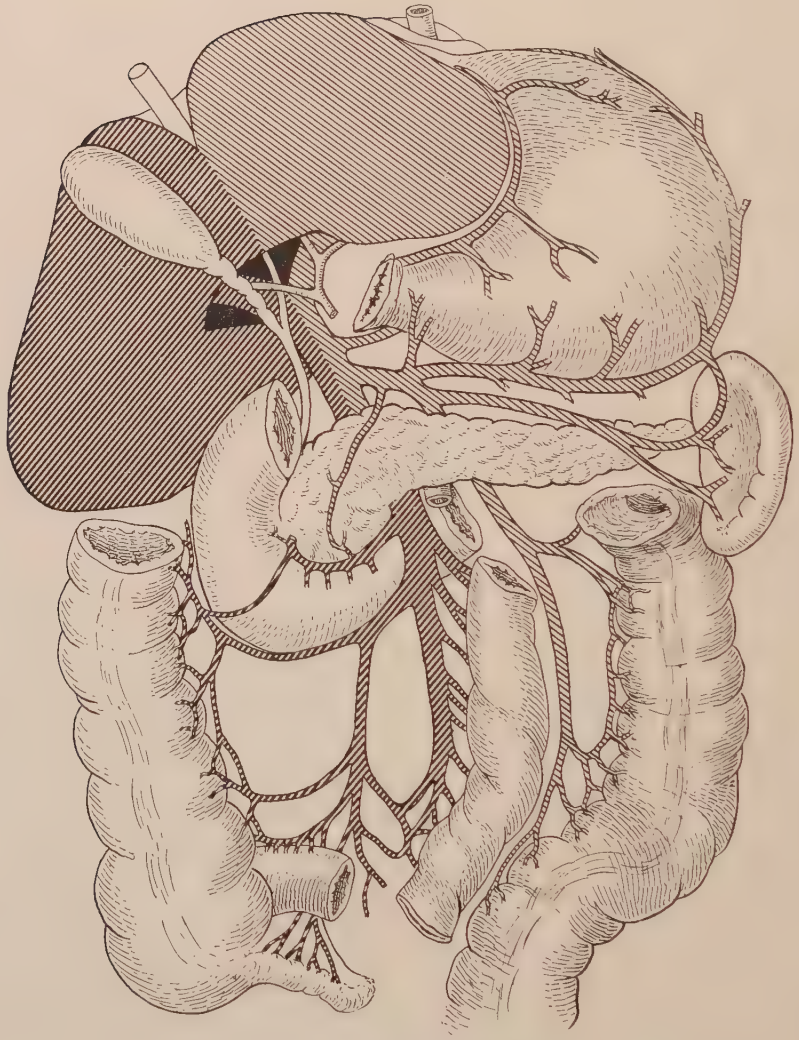

FIG. 15.—DIAGRAM TO SHOW THE RELATION OF THE LOBES OF THE LIVER TO VARIOUS ABDOMINAL STRUCTURES, INDICATED BY BLOOD CURRENTS IN THE PORTAL VEIN.

the functions of the right and left lobe of the liver. As has been known for some years, the right lobe of the liver is especially affected by enlargement in diabetes (supposedly a pancreatic disease); while in Banti's disease, and other splenomegalies, the left lobe is more particularly affected. Silvestri records some experiments of his own, and refers to others by Glénard and by Sèrègé, which tend to confirm the idea that the left lobe of the liver is intimately connected with the stomach and the spleen, while the right has more definite relations with the pancreas and small intestines. Injections of staining fluids into the spleen invariably produce a discolouration in the liver limited to the left lobe; while similar injections into the superior mesenteric radicles, made very cautiously, so as not to disturb the venous current, always stained the right lobe of the liver much more than the left. It is to be hoped that some practical application may be made of the information thus gained.

The blood pressure in the portal vein and in the liver is very low, so that hemorrhage from the liver is readily controlled by pressure or by approximation of the lips of the wound in the liver by sutures.

The *internal secretions of the liver and pancreas* are so far too little understood for anything very definite to be said about their physiological activity. The enlargement of the right lobe of the liver in diabetes, which is now generally considered a disease of the pancreas, has already been alluded to; and the recent investigations of Opie make it evident that the changes in the pancreas found in diabetes are limited almost exclusively to the islands of Langerhans.

One of the most interesting of the functions connected with the complemental metabolism of the liver, is its so-called detoxicating power over certain substances. In addition to its influence over certain alkaloidal and mineral poisons (such as nicotine, hyoscyamine, strychnine, quinine, atropine, morphine, antipyrine, peptone, and certain toxines) it is probable from some recent observations of Adami that the liver exercises a somewhat similar detoxicating power over certain forms of bacteria themselves. The state known as cholæmia, formerly thought to be caused by suppression of bile, and therefore analogous to uræmia, has been observed sufficiently often without obstruction to the flow of the bile to render it certain that it is caused

by an auto-intoxication from changes in the liver substance, not due to the damming up of the biliary excretion. For although it is quite probable that this latter condition will in most instances so injure the liver cells as to be productive of cholæmia, yet other factors such as biliary cirrhosis may be equally destructive to the liver, while the excretion of bile remains unimpaired.

The Movements of the Alimentary Tract.—Chemical digestion is supplemented by movements of the alimentary tract which provide mechanical activity necessary for the following purposes:—the preparation of the food for digestion by reducing it to a condition of fine subdivision by means of the movements of mastication; the intimate mixing of the food with the digestive juices, so as to allow of these coming in contact with every particle; the propulsion of the food from one cavity of the canal to the next as soon as the processes of digestion in the first cavity have been completed; and finally the rejection and expulsion from the body of the indigestible portions of the food-stuffs, mixed with the products of excretion of the wall of the alimentary canal itself.

Bearing in mind the uniform character of the primitive digestive tube, one would naturally expect to find similarity in structure of the walls of the matured gastro-intestinal tube. As a matter of fact, aside from variations brought about from modifications of structure and specializations of function, this is quite the case. The serosa, originally a complete tunic, becomes incomplete in those parts of the tube where but little motion occurs, as in the duodenum, ascending and descending colon. The mucosa, primarily of uniform thickness, becomes well-developed where glandular activity is greatest, as is illustrated by the thickness of the gastric, duodenal, and jejunal mucosæ, and the relative thinness of that in the remainder of the tube. In like manner, where much work is required, the muscular tunic is well developed, and, in certain locations, is specially thickened to form sphincters. Otherwise it is thin or incomplete. In this respect, it may be compared to the musculature of the cardio-vascular system. In both of these systems the circular coat is developed to a greater extent than the longitudinal. Unusual muscular effort is required of the heart and of the stomach, and in both there is an additional layer

of obliquely disposed muscular fibres. Each is the seat of rhythmical contractions. In the aorta and large arterial trunks, on the one hand, and in the duodenum and jejunum, on the other, the muscular tunics are well-developed. In the smaller arteries and the ileum the muscular tissue gradually diminishes in amount. Muscular activity in the veins and large intestine is reduced almost to a minimum, and in both the musculature is either poorly or imperfectly developed. To complete the simile, it may be mentioned that the heart and stomach are supplied both by the pneumogastric and by the sympathetic nerves, whilst the blood-vessels and intestines receive their innervation from the sympathetic system. Finally, both the heart and the stomach possess intramural ganglion-cells, which are capable of producing spontaneous contractions of these organs, even when they are liberated from all extrinsic nervous stimuli.

Deglutition.—Mastication reduces solid food to a fine pulp, which the tongue forms into a bolus. A peristaltic contraction, which consists of contraction behind the mass with inhibition and relaxation in front of it, carries the bolus down to the stomach, which it enters through the cardiac orifice. The arrival of each bolus in the stomach can be detected by auscultating the back of a patient over the region of the cardiac orifice, which corresponds to the level of the eleventh dorsal vertebra. A gurgling sound is heard each time the food passes into the stomach.

Movements of the Stomach.—The inhibition, which precedes the bolus, spreads to the entire gastric wall, so that the latter is now in a passive condition for reception of the food. The food accumulates first in the fundus. This arrangement is readily comprehended since, as was shown above, there is never any empty space within the empty stomach, its cavity being only as large as its contents.

Although "appetite-juice" is present already in the stomach, yet the latter remains in a passive condition, movements appearing only after the expiration of about 30 minutes from the beginning of the meal. During this time, and probably longer, salivary digestion continues undisturbed.

The food ingested remains in the stomach for several hours, and is ejected at intervals into the duodenum. Between these intervals,

the food is isolated in the stomach from the rest of the alimentary tract by the tonic closure of the sphincters at the cardia and the pylorus. The portion first ingested, lying in the fundus, is marked off from the antrum by a strong constriction of the sphincter antri pylori. The fundus serves as a reservoir for the food, and is subject only to weak muscular contractions. The pylorus, on the contrary, is the seat of powerful peristaltic movements by means of which the food, received from the passive fundic reservoir, undergoes thorough churning.

After the lapse of about 30 minutes, at regular intervals, small peristaltic waves begin somewhat to the cardiac side of the sphincter antri pylori, and push the food, detached from the surface of the mass in the fundus, into the antrum pylori, made a blind pouch by the closure of the pylorus. The antrum pylori now becomes lengthened, and the peristaltic waves here increase in force as digestion progresses. The pylorus remaining closed, the food cannot escape, and is squeezed back through its sole outlet, namely, the opening in the advancing peristaltic rings, thus forming an axial reflux stream toward the cardiac end. This cycle is repeated again and again, until the hard particles of food are broken up, brought into close contact with the whole of the pyloric mucous membrane, and thoroughly mixed with the gastric juice.

At varying periods the pyloric orifice relaxes, and a few cubic centimetres of chyme are squirted, with considerable force, into the duodenum. These periods vary according to the character of the ingesta, the carbohydrates leaving the stomach first, the fats next, and the proteids last. The relaxation of the pylorus becomes more frequent as digestion progresses. When gastric digestion is over, the pylorus may open to permit the passage of undigested food-particles.

Opening of the pylorus is brought about by the presence of free acid in the stomach. In this way, the acid chyme is discharged into the duodenum. The presence of acid in the duodenum, on the contrary, causes contraction of the pyloric sphincter, and also stimulates the flow of the alkaline pancreatic secretion. Neutralization of the acid in the duodenum gradually weakens this stimulus to pyloric closure, so that the cycle is repeated as often as is necessary for the emptying of the stomach. In this manner the intestine is charged

with food very gradually by the stomach, and the gastric secretion, which inhibits the action of intestinal enzymes, is neutralized in small instalments.

The well-known experiments of Kelling, which showed that filling of the duodenum inhibited contractions of the stomach, will be referred to again in connection with gastro-jejunostomy and the vicious circle.

It is not very accurately known how long food should remain in the stomach after ingestion, nor how soon the stomach should be found empty. Several hours at least must elapse; but the motor power of the stomach is said to be *delayed* if salol ingested at a certain hour cannot be detected in the urine as salicyluric acid within from forty to sixty (at most seventy-five) minutes thereafter. Salol is not absorbed from the stomach, but by means of an alkaline reaction in the duodenum. When a drop of the tincture of ferric chloride is added to urine containing salicyluric acid, a dark brownish red colour is produced.

Another test described is Klemperer's oil test, from seventy-five to eighty per cent. by weight of the ingested oil being normally discharged from the stomach within two hours. The remaining amount is detected by removing the stomach contents, dissolving them in ether, evapourating the solution, and weighing the residue of oil.

A few words may be devoted in this place to the mechanism of **vomiting,** a symptom which is of such common occurrence in diseases of the upper abdomen as to warrant the surgeon's particular attention. Vomiting is produced largely by contraction of the abdominal muscles, acting upon a fixed diaphragm, the stomach being compressed between the two. No doubt the stomach itself contracts spasmodically and aids in the ejection of the food; but this action is of comparatively trivial importance. Sensory impulses to the gastric mucosa are the chief cause of vomiting, although, as is well known, certain sights, certain tastes, and irritation of the uvula or the pharynx will in many persons have the same effect, or at least produce nausea. Sudden blockage of the urinary bladder or of the gall bladder by a calculus may produce the same result, and an analogous condition is described as appendicular colic.

Movements of the Small Intestine.—The small intestine

presents two kinds of movements, the rhythmical or pendular, which predominate, and the peristaltic.

In the pendular movements, the coils of gut sway from side to side, and, by contractions of the circular musculature, split the column of food into a number of small segments. Soon each of these segments is divided in half, and the corresponding halves of adjacent segments re-unite. This process is repeated again and again at the rate of seven changes a minute. Now and then the segments are carried onward a certain distance by an advancing peristaltic wave, and collected into a new mass. Rhythmical segmentation again occurs in this new situation. In this way the food is thoroughly mixed with the digestive secretions, and every particle is brought into intimate contact with the absorptive walls, since with each constriction the mucous membrane is plunged directly into the midst of the small segments.

The duodenal sphincter described by Ochsner aids materially in mixing the chyme just received from the stomach with the duodenal secretions.

The peristaltic movements carry the unabsorbed material onward through the ileo-colic sphincter into the colon. Regurgitation from the colon into the ileum is prevented by the tonic contraction of the sphincter, and by the obliquity of the ileo-cæcal valve.

Movements of the Large Intestine.—The presence of the semi-fluid contents in the colon starts up anti-peristaltic waves; these begin near the junction of the ascending and the transverse colon, at which point there is a physiological muscular contracture, namely, the cæco-colic sphincter (Mayo), and travel slowly toward the cæcum, carrying the food into the latter. Regurgitation being impossible, part of the food must slip back in the axis of the tube, with the same effect as occurs in the pylorus. Sacculation of the large intestine heightens the efficiency of these movements. By these churning movements, the contents of the gut are mixed thoroughly with the enzymes of the small intestine, and well exposed to the actively absorbing wall of the large intestine.

Occasionally a true peristaltic wave, excited by distention of the cæcum, and initiated in the latter organ, carries the food to the transverse colon. This wave, however, soon dies away, and most of the

food is carried cæcalward again by the anti-peristalsis. As the ascending and transverse colons are gradually filled with food from the ileum, and as absorption proceeds, the drier portions accumulate toward the splenic flexure, where they are probably separated from the more fluid parts by transverse waves of constriction, and eventually collect in the omega loop and rectum as fæces.

As illustrative of the interrelation which unites the digestive processes in an orderly series of successively dependent events, Cannon sums up as follows:

"Chewing food that is relished starts the flow of gastric juice; gastric juice in the duodenum is the cause of flow of bile and the pancreatic secretion; the pancreatic secretion in turn stimulates the formation of kinase, which activates the trypsinogen. Similarly, on the motor side of digestive activities, the presence of material in the stomach normally starts gastric peristalsis; acid in the stomach seems to be the signal for the opening of the pylorus, and food is discharged; the acid food in the duodenum closes the pylorus and originates segmenting movements to churn together the food, pancreatic juice, and bile. Peristalsis carries the masses forward; now in new situations their presence occasions segmentation. Finally, the remnant of the food is forced from the ileum into the colon; and each new accession to the accumulation there, is followed by a series of antiperistaltic waves which serve to abstract still further the valuable constituents of the food. When a certain amount of useless waste has gathered in the transverse colon, forward peristaltic waves move it slowly to the rectum to be discharged."

Applied Physiology.—Above, we have given a brief account of the secretory, absorptive, and motor activities of the gastro-intestinal tract. Let us see what practical application can be made of these facts. In other words, let us consider briefly the subject of applied physiology.

In the first instance, attention has already been directed to the importance of a good set of *teeth*. Here, at the very entry to the gastro-intestinal tract, is a necessary set of organs, the integrity of which is so essential to secure the best results from digestion. Yet too often

the teeth are found incomplete in numbers, or the seat of varying degrees of decay. There is small wonder for this, not only because in the human race the teeth are undergoing inherited retrograde processes due to unnatural preparation of foods, but also because the dental organs are subjected to the action of the oral micro-organisms and their products, as lactic acid. Hence, we believe the teeth should be put in, and kept in, the best condition possible, and, for the sake of emphasis, we should like to harp longer on this subject, did space permit.

The importance of sterilizing the mouth as far as possible, and the food that enters it, in the preliminary preparations for operations on the stomach, is known to all clinicians. So, too, is the regard for the teeth in the administration of hydrochloric acid.

The *stomach* is worthy of more attentive care than it usually gets. It is not just to dispose of it, from a physiological standpoint, lightly as a mere convenience for the storage of food. The bladder and the rectum, if one wish, may be considered as convenient reservoirs, but it must be remembered that these organs are the terminals for, respectively, the urinary and the digestive apparatus, and they have no other function than that of storage. The stomach, on the contrary, is at the very portals of the digestive tube. Not only does it possess definite enzymotic and motor functions, but it is also a sensitive organ, endowed with selective powers, in that it retains wholesome food, and rejects that which is detrimental or injurious. That the stomach is one of the most sensitive organs in the body cannot be denied, and it is equally true that for this reason, if for no other, it should receive much consideration, like other sensitive things. Situated between the harmful objects, bacterial, chemical, and physical, of the outside world and the delicate intestines, it exercises a distinct protective function over the gut. But it is a mistake to consider the stomach, or any other part of the gastro-intestinal tract, as a separate and distinct entity. Its embryological and physiological relations forbid this, and such is equally true of the other bodily systems, such as the nervous, the respiratory, the circulatory, and the urinary. The intimate functional interrelations of the various continuations of the gastro-intestinal tract have been remarked upon, and these inter-

relations operate not only physiologically, but pathologically. Were it of any avail, we should further decry abuse of the stomach. We demand, however, that it receive consideration solely in conjunction with the remainder of the system with which it is correlated.

The great value the *appetite* holds in the interests of the œconomy cannot be overestimated. Like other instincts, it cannot be neglected with impunity. To restore appetite to a sickly patient is to confer upon him a boon, the effects of which are far-reaching. Not the least of these is the preservation of the integrity of the body by enriching the blood, thereby increasing the protective and defensive powers of the organism.

In the first instance, regular hours for the intake of food are as important as for the ejection of the residue from the body. Food should not be gobbled, but should be well masticated, and eaten with discrimination and care. To secure the best results, the attention should, as far as possible, be concentrated upon the process of ingestion. The degree of enjoyment with which food is taken is enhanced by the attractiveness with which it is prepared. Furthermore, the patient's tastes should receive due consideration.

Even should these conditions be fulfilled, appetite, and consequently, appetite-juice, may still be absent. In this instance, feeding would be forced; such a method is unnatural, and frequently the stomach rebels against it. Here the aim should be to restore the appetite, for this means copious secretion of gastric juice to act upon the ingesta. It would be wise to administer a cup of beef-broth shortly before meal-time, for both the water and the beef-extract contained therein are undoubtedly strong excitants of gastric juice. In the same way, suitable doses of hydrochloric acid may be carefully given, since acids are specific stimuli to the pancreas. Further, it is often beneficial to order food in small quantities, frequently repeated. By this method, too much work is not thrust suddenly upon a stomach impaired in its activity, and appetite-juice, which is so powerful, is repeatedly called forth.

For patients in whom the sense of taste is impaired, bitters may be found very useful. Not only do these stimulate the gustatory cells by means of contrast to pleasant sensations, but also they produce a

certain psychic effect, and this, in turn, indirectly excites a physiological secretory activity.

Milk is a rational food for the sick, in that it nourishes the organism with the least degree of work on the part of the digestive tract, since it provokes the weakest gastric juice and the smallest amount of pancreatic fluid, and hence gives these organs rest. This rest is very desirable when the gastric glands manifest excessive activity. Alkalies, also, exert an inhibitory influence upon the digestive glands. The value of large doses of sodium bicarbonate in hyperchlorhydria is well known. It reduces the secretion in the stomach, and, by diminishing the acidity in this organ, restrains the activity of the pancreas. On the other hand, when administered in small doses, this salt, theoretically from a chemical standpoint, calls forth an increased output of hydrochloric acid.

Just as any irritating substance, bacterial, physical, or chemical, evokes hypersecretion from any mucous or serous surface, so does it from the very extensive mucous membrane of the gastro-intestinal tract. This overproduction of mucus is protective in nature, in that it comes from the surface epithelium, and thus wards off the danger that threatens the more important elements of the mucous membrane beneath. Therefore, many forms of diarrhœa are expressive of defence on the part of the organism.

In the same way, defensive activities in the peritoneal cavity are carried out by the omentum upon the serous tunic of the intestines. Thus, according to Dickinson, Buxton, and Torrey, quoted by W. J. Mayo, the omentum is a most important agent in developing phagocytosis and opsonins; its germinating endothelium is constantly producing lymphocytes and is capable, under proper stimulation, of throwing both newly formed phagocytes and those called from a distance into germicidal action. This wiping process is greatly aided by the vermicular and swaying movements of the intestines, which, in spite of gravity, bring all parts of the wall of the small gut in contact with the omentum, the epiploic tags having the same function for the more fixed large intestine.

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CHAPTER III.

GENERAL DIAGNOSTIC CONSIDERATIONS.

Although the diagnosis of each surgical affection discussed is treated in considerable detail in the special chapter devoted to the subject, yet it is convenient in this place to dwell upon certain general considerations in regard to diagnosis, which are of nearly equal importance in every surgical affection of the upper abdomen. And we do this with the greater confidence, because we fear that some surgeons who are called in merely as consultants may be tempted to take the diagnosis of the malady ready made from the physician, and to regard the operative treatment of their patients as the only province particularly belonging to surgery. This attitude of mind, we venture to suggest, is not only derogatory to the profession of surgery, but inimical to the ultimate interests of both patient and surgeon. While we realize that all progressive physicians are now anxious to have a surgical consultation in the case of most of the diseases of the upper abdomen which do not readily yield to hygienic and dietetic measures, we are also well aware that they are loath to consult a surgeon who can offer no other advice than to adopt the plan which is colloquially referred to as "taking off the lid." It is admitted by all that it is desirable for the surgeon to have a thorough appreciation of the natural course of the morbid process going on within the patient, in other words, that he must be well grounded in the pathology of these diseases; but it will be impossible for him to give an intelligent opinion on such questions, unless he is first able to determine what the disease really is. To put it in the plainest terms, a consultant must be able to render an opinion which will be worth the asking; and unless his diagnostic acumen is of the highest, physicians will soon perceive that it is for their patients' interest to go elsewhere.

Anamnesis.—In every case, there is no surer foundation on which

to lay the facts which go to make up a correct diagnosis, than an accurate and complete history of the patient's past medical life and present complaint. It is exceptional indeed for such a history not to point the way toward further investigations which will reveal the true malady. It may seem tedious and commonplace to both patients and surgeon to lay stress on data such as age, occupation, general habits of diet, previous illnesses, etc.; but neglect of one minor detail may distort the clinical picture, and lead the diagnostician very seriously astray.

In addition to the patient's history, the careful diagnostician will take advantage of every fact that may be learned from a complete physical examination, including *Inspection*, *Palpation*, *Percussion*, and *Auscultation*; *Mensuration* also may be of value in a few instances.

Inspection.—The patient should lie flat on the back, with the entire abdomen and lower thorax bared, and in a good light. The general contour of the abdomen should be noted, whether fat or emaciated, tense or flaccid; together with the presence or absence of localized bulging, of peristaltic waves, of scars from previous operations, etc. Attention should be directed to the character of the breathing, whether it be natural or affected by the surgeon's examination; whether it be shallow and rapid, and confined to the chest, as is often the case in the presence of peritonitis; or whether the normal full abdominal breathing be present, which usually denotes the absence of any painful abdominal condition; or irregular, short, spasmodic breathing, which sometimes indicates implication of the diaphragm; or possibly the long, sighing respirations, as of "air hunger," often seen in cases of internal hemorrhage. The appearance of the costal angle should be noted, as well as any undue bulging or depression of the pit of the stomach. The configuration of the thorax, as indicative of tight lacing, may prove of diagnostic value in certain affections of the liver and stomach.

Palpation.—This is the most valuable of all means of physical examination at the command of the surgeon. It should never be omitted, and should always follow inspection. In order to obtain the greatest number of diagnostic points by its means, it is important to have the abdominal muscles as relaxed as possible. This relaxation

is best secured by having the patient's head and shoulders slightly elevated, and by flexing the thighs on the abdomen. The thighs should be passively, not actively, flexed; so that it is best either to support the knees by placing a pillow beneath them, or to have the thighs flexed so far that the soles of the feet will rest comfortably on the bed or couch on which the patient lies.

The hands of the diagnostician should always be warm, so that no reflex spasm of the abdominal muscles will be caused by chilling from contact of the hands. It should be an invariable rule to begin the palpation in some presumably healthy region of the abdomen, in order to accustom the patient to the palpating hand before the diseased area is reached, and to ascertain, if possible, the natural condition of the belly wall in health. The patient's attention may be diverted from the local examination by conversation. The entire abdomen should be thoroughly examined by palpation, the hand being allowed to slide over its surface rather than being raised and again laid on the skin, for fear of producing involuntary contraction of the abdominal muscles from the new contact.

The degree of rigidity in all portions of the abdomen must be noted. Attentive examination should be made of any tumescence detected, noting especially its location, its consistence, its density, its fixity, its general conformation; the presence or absence of movement during respiration; its mobility, and if any, in what directions; and finally its relation to surrounding structures must be considered.

The degree of tenderness present in the various portions of the abdomen must be noted, together with the amount of pressure necessary to provoke it. The degree of tenderness to pressure, combined with the rigidity of the abdominal wall at the site of the tenderness, will often be of marked diagnostic significance.

The presence or absence of a succussion splash in the stomach may be determined by means of palpation. This splash is very significant in cases of gastrectasis if found in certain relation with meals, as it will indicate decided lack of gastric motility.

Percussion.—This is of the utmost value in mapping out the relation of the various abdominal organs. It will reveal the size and position of the liver, the position of the colon, of the stomach, and of the

spleen; the presence or absence of hepatic dullness; the presence or absence of free fluid in the abdominal cavity, etc. In many instances much additional information is to be gained by distending the stomach with air or liquid, so that its position and extent can be definitely determined. The air should be forced into the stomach by means of a hand bulb on the stomach tube; we do not approve of the use of an effervescing powder for inflation of the stomach, because this latter method cannot be controlled, and may lead to serious results; moreover, it certainly causes much more discomfort to the patient than does the use of a stomach tube, by means of which the amount of air introduced can be accurately regulated. The patient himself is the best judge of the amount of air to be introduced; and the least discomfort on his part should make the surgeon desist from introducing more air. The same is true for the introduction of fluids, either for the purpose of distending the stomach, or for washing it out. If any doubt as to the outlines of the stomach remains after distention with air or fluid has been tried, it is at times advisable to inflate the colon with air while the stomach is distended with fluid. In this way percussion will reveal their relative positions with great accuracy, and may throw much light on an obscure condition, or reveal the exact location of any tumor that may be present.

Auscultation.—Auscultation alone, or in combination with percussion, may be of decided value in the diagnosis of diseases of the upper abdomen. It is well known that the time when food or liquids enter the stomach can be detected by auscultating the thorax about three inches below the angle of the left scapula. It is well for the inexperienced to listen to the normal sound in healthy individuals, many times, before attempting to diagnosticate a lesion of the œsophagus or cardia by this method. The amphoric, rushing sound is heard from three to seven seconds after the act of swallowing; if delayed more than ten seconds, it is safe to infer that some obstruction, spasmodic or organic, is present.

Auscultatory percussion is sometimes of aid in determining the exact outlines of a distended stomach; the stethoscope is placed over the air-containing organ to be outlined, and an assistant gently percusses from surrounding structures toward that over which the

stethoscope is placed; as the border of the distended stomach is crossed, the change of note is very perceptible through the stethoscope. In a similar manner, the coin test may be used in an air-containing cavity, such as the stomach, or a subphrenic abscess in direct connection with the gastro-intestinal tract.

Mensuration.—This is occasionally useful to record from time to time variations in the amount of abdominal distention; to note increase of ascitic fluid; to compare one side of the abdomen with the other, etc.

General Health.—In deciding for or against an operation it is of course requisite for the surgeon to take into consideration the general health of the patient. The state of the heart, the lungs, and the vascular system should be attentively studied; and careful examination should be made of the amount and quality of the urine excreted. Myocardial disease will be in general more of a contraindication to operation than will a well compensated valvular lesion. The gastric and intestinal manifestations of nephritis should be kept constantly in mind.

Gastric Analysis.—The analysis of the stomach contents, and the determination of the motility of the organ, are at times a considerable help in arriving at a correct diagnosis. Sometimes advantage may be taken of the opportune vomiting of the patient, who thus places at the disposal of the examiner sufficient material for analysis and study. Usually, however, it is necessary to give a "test meal," and to withdraw this by means of the stomach tube in a specified time. The test meal we employ consists of one piece or slice of Zwiebach and a small cup of weak tea, given on a fasting stomach. The stomach is then emptied by the stomach tube one hour after the ingestion of the meal. We also think it of considerable value to test the gastric motility by evacuating the stomach six hours after the ingestion of an ordinary full meal; if the motility is normal, there should be practically no residue after this lapse of time.

This, of course, is not the place to describe the various methods of gastric analysis. They are fully discussed in many special treatises, as well as in most text books on medicine.

Passing the Stomach Tube.—The stomach tube should be in

good condition, and its surface should be perfectly smooth. As soon as the surface begins to crack, the tube should be discarded. The tube should be cleansed and boiled after using; it should then be dried in the air and put away. It is not necessary to boil it again just before using, though it is often desirable to do so; but repeated boiling soon destroys it. When the stomach is to be inflated with air, the tube should have a hand bulb attached to it about 25 cm. beyond the "tooth mark." The valve on the bulb should be kept in good working order. Air will escape spontaneously from the inflated stomach, through the tube, as soon as the bulb is detached. To withdraw fluid from the stomach, syphonage will usually suffice; but by reversing the hand bulb, the apparatus may be converted into a suction pump.

If the patient is strong enough, it is more convenient to pass the tube while he is in a sitting posture; if necessary, however, it is quite possible to introduce it while he is lying down. In most cases sufficient lubrication will be afforded by the mucus in the pharynx and œsophagus, the tube being dipped into lukewarm water just before being introduced. Oils or other lubricants are usually very disagreeable to the patient. A mouth gag need not be employed except in children and unconscious or refractory patients.

The surgeon, facing the patient, and having his own clothing, as well as that of the patient, suitably protected, takes the stomach tube, about six inches from its end, in his right hand, holding it as a pen; then, directing the patient to open the mouth widely, he passes the index finger of his left hand into the patient's mouth. In the excessively nervous the uvula and palatal arches may be cocainized. With the left forefinger as a guide, and drawing forward on the base of the tongue, the stomach tube is gently, but firmly passed back until its end touches the posterior wall of the pharynx. By then guiding its point downward with the left index finger, it is gradually fed onward by the right hand; and by keeping it close against the posterior pharyngeal wall, it will glide into the œsophagus. At this moment the patient, if the stomach tube is being passed for the first time, usually gags, and feels as though he were smothering. If he is assured, however, that all is going well, his momentary distress is quieted, and

he will find himself able to breathe comfortably in spite of the presence of the tube in his gullet. Then, as the patient makes slight efforts at swallowing, the tube is allowed to glide down into the stomach, until the tooth mark reaches the dental margin. It is very seldom that force is required, when once the end of the tube has become fairly engaged in the œsophagus; and if the surgeon is gentle and patient in his manipulations, the patient will find that the ordeal of having a stomach tube passed is by no means unbearable; indeed that it is much less disturbing in reality than in anticipation.

After a patient has had a tube passed once or twice, no guiding finger will be necessary, and the patient very often will prefer to pass it himself, instead of having this done by the surgeon. Those who are in the habit of having stomach tubes passed experience very little more discomfort than is felt in passing a soft rubber catheter through a normal urethra.

Lavage of the Stomach.—Tepid water, either alone, or with a little bicarbonate of soda added, is the liquid that is usually employed. For patients with marked fermentative changes, a weak solution of permanganate of potassium is useful. Not more than ten or twelve ounces should be passed into the stomach at first. This should be done very gradually, with the funnel of the tube very little higher than the level of the stomach. The feeling of beginning discomfort on the patient's part is the safest indication of the amount to be introduced at one time. In unconscious patients, and in those with marked disease of the stomach, only a very small quantity should be used at any one time; and even greater gentleness than usual should be employed, on account of the danger of producing rupture of the stomach (see p. 327). After the proper amount has been introduced into the stomach, the funnel should be lowered and then inverted over a waste bucket, and the gastric contents syphoned off, the process being repeated until the fluid returns clear.

Skiagraphy in Diagnosis of Lesions of the Upper Abdomen.—In cases where the ordinary methods of physical examination leave the diagnosis in doubt, or where it is desired to obtain confirmation of a diagnosis, the Roentgen, or X-rays, often will be of material assistance. There is but one objection to the use of the X-ray in this

connection, and that is the fact that it is useless unless employed by an expert in this particular branch of X-ray work. The technique employed is so complicated, and demands such close study, that a description of it would be entirely out of place here; but it is necessary for the clinician who is to take advantage of work being done by expert Roentgenologists to realize what aid may be given them, and what preliminary preparation of the patient is necessary to render the skiagraphic examination of value.

When possible, the patient's gastro-intestinal tract should be thoroughly emptied. This is best accomplished by means of a purge and abstinence from food. Liquids may be administered if necessary, but even this diet should be limited to broths, albumen water, etc. Milk is apt to form curds, and these may be very misleading, especially in an examination of the stomach for malignant disease. The patient should be prepared to remove the clothing from the abdomen. It is generally better to remove all clothing, substituting a dressing gown without buttons, or a sheet which will cover the entire body.

More information of value can probably be obtained from a skiagraphic examination of the stomach, than from that of any other viscus in the upper abdomen. This organ is studied after it has been rendered transparent by inflating it with air, or after rendering it opaque by the ingestion of some bismuth preparation. Air, as a rule, does not distribute itself well in the stomach, and is really important only in the study of the fundus or "upper pole."

The stomach normally, and except when adherent to surrounding structures, is distinctly movable and changes its contour and position with the position of the patient's body. The posture of the patient, therefore, should vary according to the portion of the stomach which it is desired to examine. The standing posture generally is the most useful. In this position the axis of the stomach is almost vertical and the organ is situated almost entirely to the left of the median line. The lower one-third is more or less horizontal, but the upper two-thirds are nearly vertical in this position. The upper pole normally rests against the diaphragm; the lower pole in the standing position reaches nearly to the umbilicus and is little lower than the pylorus. In gastroptosis the lower pole of the stomach may reach any distance below

this level. In the dorsal decubitus the greater portion of the stomach occupies the left hypochondrium. Most text-book illustrations are made with the viscera in position as seen on the operating or dissecting table, and hence do not give an accurate idea of the position assumed by the stomach when the patient is erect.

A portion of bismuth mixture may be administered with the patient standing. By fluoroscopic examination a swallow of liquid food may be seen to enter the stomach completely in about seven seconds (Pfahler.) A delay usually means some constriction at the cardiac orifice, either spasmodic or organic. If organic, solid portions of food, or bismuth capsules or pills, will be retained a longer time, according to their size, the calibre of the constriction, and the degree of solubility of the ingested material. If due to malignant change, the constriction usually can be outlined in the gaseous field which occupies the upper portion of the stomach when the patient is in a standing posture.

When the portion of bismuth mixture swallowed has passed the cardia, the bolus can be seen to enter the stomach and gradually to separate the walls of that organ as it works its way to the lower pole. A new growth or constriction in the wall of the stomach, even though small, will cause the food to change its normal course. In an hourglass constriction, the separation of the food in the upper pole from that in the lower may be clearly seen. It is generally requisite to have the stomach well filled with bismuth mixture to insure a correct diagnosis of hourglass deformity. At times a growth in the stomach can be detected by the separation of the food in the stomach from the gas in the colon, thus showing that something abnormal is situated along the greater curvature of the stomach.

New growths in the lower pole are recognized partially by the outline of the bismuth food; by the interference with the peristaltic waves, which normally are active in this portion; and at times a growth will be indicated by the immobility of the lower pole, suggesting perigastric adhesions.

Carcinoma near the pylorus will show an irregularity in the outline of the bismuth mixture. Normally the position of the pylorus is shown by a relatively transparent space between the food in the

stomach and that in the first part of the duodenum. When infiltrated with carcinoma, this area of transparency is lost or distorted. If stenosis exist, food will be retained an abnormally long time on the proximal side of this point. If, on the other hand, the pylorus is rendered rigid by the disease but remains patulous, as at times occurs, the food may be seen to pass out of the stomach nearly as fast as it enters at the cardiac orifice.

Although the factors mentioned above may be determined by the use of the fluoroscopic screen, yet much confirmatory evidence, and practically all details, must be obtained from the skiagraphic plate. Gastroptosis can be accurately recorded upon the plate; but such facts as the tone of the gastric wall, the depth of the peristaltic contractions, and the effect of the contractions of the muscles of the abdominal wall, and of the movements of the diaphragm, can only be observed on the screen.

The duodenum curves around the head of the pancreas, and by observing the outline of the former, some information may be obtained as to the probable size of the head of the latter. A constriction of the duodenum may at times be shown by a dilatation of the portion preceding the stricture.

The liver usually can be outlined, but the X-ray will not be of much value in this determination, as other means at our disposal are just as accurate and more readily applied. The presence of gall-stones can be shown occasionally, but their density is so slight that failure to demonstrate their presence will by no means indicate their absence. Large amounts of adipose tissue between the gall-bladder and plate, or a large collection of bile in the bladder very often will render impossible the demonstration of gall-stones. As a rule, the information concerning the gall-bladder obtained by means of the X-ray can be used only as confirmatory and never as negative evidence.

The spleen usually can be outlined by means of the rays, but so far they have been used very little for this purpose.

A subphrenic collection of pus usually will cause a change in the normal contour of the diaphragm on the affected side. The diaphragm will be pushed upward and its normal excursion will be dis-

tinctly lessened. When the abscess is secondary to thoracic disease, this fact usually can be demonstrated.

Diaphragmatic hernia can be recognized by a displacement of the lung tissue or heart by a transparent body. In a few instances it has been possible to distinguish by means of the X-rays between diaphragmatic hernia and eventration of the diaphragm.

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CHAPTER IV.

BENIGN DISEASES OF THE STOMACH AND DUODENUM.

GASTRIC ULCER.

It is usual to classify gastric ulcer as acute and chronic; but as one form grades into the other by almost imperceptible degrees, and as it is frequently impossible to tell during life to which of the classes the ulcers in question belong, such distinctions seem to be a refinement, and of greater pathological than clinical interest. It would be better to classify ulcers of the stomach as "open," and "healed or healing," for thus the surgeon would be in a position to express readily the difference between the two main varieties which are distinguished by their symptoms. As will be seen later it is really the state of the ulcers in regard to the stage of their cicatrization that determines the symptomatology, and not mere duration. An ulcer which has existed for twenty years will still be "acute" if it is unhealed, and is liable to hemorrhage or perforation; while one which in the space of a few months has passed through the stages of granulation, cicatrization, and contraction will become chronic as soon as the cicatrizing and contracting process has exceeded the ulcerating feature of the lesion. Of course, certain ulcers of the stomach may be ulcerating in one portion of their surface, while they are cicatrizing and contracting in another; but even if this be the case, the latter features usually will overshadow the former, and the ulcer is to all intents and purposes a healing ulcer.

Ætiology.—Gastric ulcer is one of those diseases for which no satisfactory cause has yet been found. After discussing with more or less approval the various theories advanced by ardent investigators, most authors are content to return to the statement that no one cause is always operative, and that the essential conditions for the production and perpetuation of an ulcer of the stomach are, first, some lesion to

the gastric mucosa, and, second, impaired resistive power of the mucosa itself. And then we are reminded that this reduces the question to Hunter's original theory of a "vital principle" which enabled the gastric mucosa, while living, to resist the disintegrating action of the gastric juice. Different writers have cited different examples of the lesions, and of the cause of the impaired resistive power.

It is probable that a more intimate knowledge of the correct action of the various organs associated with metabolism, brought about by the continued study of the normal physiology of these structures and the changes shown by the living pathology as seen on the operating table, will allow us to state definitely, in the near future, the exact ætiological factors of gastric and duodenal ulcers. At present we can only theorize, accepting for the time being those theories which seem to be most thoroughly substantiated by our findings at the bedside, at the operating table, and in the laboratory.

As to the *frequency* of gastric ulcer, no very satisfactory statistics exist; the most frequently quoted figures are those of Brinton and of Welch, which tend to show that gastric ulcer is found in five per cent. of mankind. At the present time writers are inclined to consider it an even more frequent disease.

Predisposing Causes:—Climate.—It has been proved by statistics that geographical location has a decided influence on the frequency of gastric ulcer. Welch gives the statistics of various different cities, and Douglas concludes that it is more common in northern than in southern latitudes.

Age.—When we consider statistics as to age we are at once confronted with the difficulty that it is almost impossible to tell how long an ulcer has existed, or, in other words, at what age it first made its appearance. In most autopsy reports no differentiation is made between open and healed or healing ulcers; nor is it always possible to obtain a clinical history of the patient which would throw light upon the length of time symptoms of gastric ulcer had been present. The statistics of Brinton include all stages of ulcer found at autopsies. Welch collected 607 cases of open ulcer and found that 33 (5.43 per cent.) were in patients less than twenty years of age; 226 (37.2 per

cent.) were in those between the ages of twenty and forty; 222 (36.5 per cent.) were in patients between the ages of forty and sixty; and 126 (20.7 per cent.) only, in patients over sixty years of age. The largest number of cases (119) in any one decade was found between the ages of twenty and thirty. One case was that of a child less than ten years old; there was one patient over one hundred years of age. Bechtold has recorded the case of a girl of five years who died from perforation of a gastric ulcer; and Parkinson has recorded a similar condition in a child two years of age. It is probable that these ulcers in children are closely related to the toxæmias of infancy (see p. 71).[1] Van Valzah and Nisbet conclude that one-half of the cases have their beginning between the ages of twenty and thirty, and about four-fifths between the ages of twenty and forty years.

Sex.—It is generally admitted that females are more liable to gastric ulcer than are males. Recent surgical experience seems to show that females are, moreover, peculiarly liable to suffer from the acute symptoms of ulcer, whereas males do not, so frequently, present symptoms of sufficient seriousness to require treatment until the ulcer has reached the cicatrizing stage which compels them to seek relief from pyloric or other form of obstruction. In a large number of cases it is accurate enough to say, with Welch, that females form 60 per cent. and males 40 per cent. of the total.

Occupation, especially among females, has long been considered a predisposing cause of gastric ulcer. The sedentary habits of seamstresses, dressmakers, governesses, and other women with similar occupations are in themselves sufficient materially to reduce the resistive power of the gastric walls and thus render the mucosa more liable to the deleterious effects of exciting causes which in healthy individuals would be trivial.

Other Diseases in the upper abdomen may act as predisposing causes of gastric ulcer. Adhesions between the biliary apparatus

[1] G. K. Paterson, in reporting an operation by Caird for perforation of a gastric ulcer in a boy of 12 years, collects 15 others in children under 14 years of age. The only operation besides Caird's, was recorded by Cheyne and Wilbe; both patients recovered. All the other perforations were verified by autopsy, the diagnosis not having been made in most during life. The youngest child was 45 hours old, the next youngest was two months old, and the third was one year.

and the stomach are generally recognized as all-important factors. These adhesions impair the gastric motility, disturb the gastric circulation, and in these ways produce an area of lessened resistance which predisposes to ulceration. We have seen many cases in which this course of events was too clear to be denied. These secondary gastric changes often cause more discomfort than the original disease.

Rasmussen has suggested that tight lacing might act as a predisposing factor in the causation of gastric ulcer, by impairing the circulation and motility of the stomach either directly or by first producing a "corset liver." This was apparently the case in the patient whose stomach is pictured in Fig. 23.

Typhoid ulcers of the stomach are rare. According to Gandy, such cases have been recorded by Papellier, Jones, Poisson, Millard, and Chauffard. Proskauer found typhoid ulcers of the stomach, duodenum, and entire intestinal tract at autopsy on a boy 9 years of age, who had been operated on for diffuse peritonitis of undiscovered origin. There were no perforations found.

Syphilitic and *tuberculous* ulcers of the stomach are considered at pp. 238, 245.

An impaired condition of the blood such as is found in the *anæmias* has, by many authorities, been considered the chief contributing cause of ulcer of the stomach.

The foregoing predisposing ætiological factors of gastric ulcer act almost entirely by impairing the natural resistance of the gastric mucosa to any injuring force, no matter what the nature of the latter may be.

Exciting Causes:—Trauma by ingested food is considered by many to be the main exciting cause of gastric ulcer. *Acute distention* of the stomach, by mechanically producing slight ruptures of the mucosa, may act as a mechanical cause of gastric ulcer (Strassmann, Moullin). From the evidence which has been accumulated in recent years, it seems to us that it is most rational to accept some form of *toxæmia* as the exciting cause of gastric ulcer.

The theory of the **toxæmic origin** of gastric ulcers has much in its favour. It was elabourated by Nauwerck, has been supported by Dieulafoy, and forms the subject of the thesis of Gandy, which should be consulted by all who are interested. Gandy shows that in prac-

tically all toxæmias there are gastro-intestinal ulcers, and that in practically all cases of gastro-intestinal ulceration there is present some form of toxæmia. He points out the remarkable similarity which exists between the ulcers of toxæmias (including the intestinal ulcers met with in cases of burns), and the so-called simple ulcers of the stomach. They are alike in latency, in tendency to hemorrhage and perforation, and in their acute formation. They are also alike in their clinical course: the earliest stage in all is ecchymosis; then hemorrhagic infarct; slough; hemorrhagic erosion; "exulceratio simplex" of mucosa; true ulceration with hemorrhagic borders; and finally perforating ulcer, or chronic ulcer with thickened border, or a cicatrix. He was able to trace these forms in (1) burns; (2) infantile diseases (melæna); (3) infections (erysipelas, septicæmia, pyæmia, local septic infections, variola, scarlatina, purpura, puerperal infection, infections of uterus and adnexa; infections of genito-urinary apparatus, strangulated hernia, biliary infections, pneumonia, pleural infections, phthisis, diphtheria, articular rheumatism, rabies, tetanus, cholera, dysentery, typhoid fever, etc.). In infantile diseases, burns, and typhoid fever he was able to find pathological changes representing each of the degrees above mentioned, beginning with ecchymosis, and ending with perforation. He remarks, further, that observers have for many years noted all the above lesions in other parts of the stomach or digestive tube, in cases of gastric ulcer, but do not seem to have appreciated the fact that they probably represented earlier stages of the same process. In patients with gastric ulcer it is probable that the toxæmia is always of infectious origin; and previous lesions of the liver and kidneys, by increasing the toxæmia, act as predisposing causes.

Quite recently somewhat similar views have been expressed by Hort, who evidently has worked in ignorance of the labours of Gandy and of Dieulafoy. With the advantages which the most recent researches in chemical biology have placed in the physician's power, Hort has been able to carry the theory of the toxæmic origin of gastric and duodenal ulcers one step further than hitherto. He thinks gastric ulcer, including, as above stated, ecchymosis, erosion, and actual ulcer, is due to a general blood disease, in the nature of a

toxæmia, the local effects in the stomach being due to the production of hæmorrhagins, which eat through the endothelial lining of the blood vessels, and secondly to mucolysins, which destroy the gastric mucosa. Ecchymosis, recognized as the first stage in the production of a gastric ulcer, is produced by the hæmorrhagins alone; when the mucolysins also act, an erosion is produced, and in time a fully developed ulcer will be found, unless antibodies are formed by the organism to hold these cytolysins in check. These cytolysins affect the gastric mucosa through either the lymph stream, "constantly flooding epithelial cells with the specific toxins (mucolysins) or from escaped blood charged with the same bodies (hæmorrhagins, mucolysins)." Hort concludes (1) that no other theory as yet put forward brings into line such apparently incongruous manifestations as ulcer without hemorrhage, hemorrhage without ulcer, perforation without hemorrhage, etc.; (2) that it is useless to expect to find in the dead house conclusive evidence of cause and effect of hemorrhage and ulcer beyond that of extravasation; (3) that the present day medical treatment of the conditions must be modified; and (4) that the use of surgery in combating a profound toxæmia must be carefully restricted. The proofs he promises to offer in a further communication consist of: I. Direct evidence of cytolysis in these affections shown by (a) blood examinations, (b) remarkable results of treatment by serum and vaccines in his own hands. II. Collateral evidence (A) of cytolysis in other similar diseases, shown by (a) blood examinations, (b) serum and vaccine therapy for such diseases in the hands of others as well as in his own hands; and (B) of cytolysis in the lower animals shown (a) by producing these lesions, and (b) by curing them by serum and vaccine therapy. Were this theory of the toxæmic origin of gastric ulcer to be proved correct, it would certainly simplify our ideas as to the pathology of this affection, as well as afford an explanation for many obscure gastric and intestinal hemorrhages.

John B. Roberts has collected sixteen cases (including two in his own practice) in which gastric lesions followed soon after, and were apparently caused by, operations on the urinary bladder. All such observations, it seems to us, lend support to the theory of the toxæmic origin of gastric ulcer.

Clinical Pathology.—Gastric ulcers are more often *multiple* than has usually been supposed. Brinton reported multiple ulcers in only 21 per cent. of cases; but it has been found, when special attention is directed to this point in post-mortem examinations, that multiple ulcers are found much more frequently than this; and certainly at operation it is much more usual to find the evidences of several ulcers than it is to find only one. Indeed, we think it is not incorrect to state that ulcers are more often multiple than single in all patients, although it may be one particular ulcer that gives rise to prominent symptoms.

The *site* of the ulcers is usually toward the lesser curvature, and much more often in the pyloric region of the stomach than elsewhere. Ulcers are also more frequent on the posterior than on the anterior wall of the stomach. The ulcer may be latent, especially if on the lesser curvature. Savariaud says that latent ulcers occur in one-fifth of all cases of gastric ulcer; and, as Robson and Moynihan suggest, the situation of the ulcer is probably a sufficient explanation for its latency. The frequency of involvement of the pyloric portion is likewise explicable on mechanical grounds, as it is this portion of the stomach that is most actively in motion during digestion, and is therefore most liable to traumatism from the contained food. By the same reason is explained the occurrence of duodenal ulcer, which is more often found to be coincident with gastric ulcer than existing alone. The existence of similar ulcers on the anterior and posterior gastric walls (the so-called "kissing ulcer") is more probably due to similar relations to the blood supply than to any fancied infection of another portion of the stomach by an existing ulcer.

The *course* pursued by gastric ulcers does not differ materially from that of ulcers of any other region of the body exposed to such constant traumatism. If the ulcer is sufficiently severe in character to compel attention and procure appropriate medical treatment in its early stages, it is prone to heal by cicatrization and contraction without much puckering of the gastric surface, and does not as a rule give rise to further trouble later in life. The small white scars left by such ulcers are seen by the surgeon constantly in his operations. If, however, the symptoms at the onset of the ulceration are not very acute,

suitable treatment is often neglected, and the patient suffers from various grades of gastric indigestion, since various factors tend to prevent the spontaneous healing of gastric ulcers. Ulcers of the stomach have been compared to leg ulcers, and the resemblance is in many respects close. Both develope insidiously, and are endured by the patient because not very acute in character, and because proper treatment would necessitate interruption of the usual activities of life. If a leg ulcer, when in an early stage, could be treated by rest in bed, and if such treatment could be persisted in until a cure was really produced, recurrence of the lesion would be unusual. The same may be said of the gastric ulcer. But, as Robson and Moynihan have remarked, the acute pain in both cases ceases as soon as the cicatrizing process has fairly commenced; and as soon as the acute symptoms subside, the patients want to be up and about again, with the result that the ulcer, whether of the leg or the stomach, is never really cured. So that even simple ulcers, if treatment be not carried to proper length, will be prone to become chronic, and to resemble in type those ulcers which were only sub-acute in type at their origin, and which therefore received no treatment at all. The constant use to which the stomach must be put, the periodical outpouring of the irritating acid secretion of the gastric mucosa, and the recurring mechanical traumatism of the food, all tend to prevent healing of an ulcer which has once formed. Add to these factors which are present even in healthy individuals, those which are operative in an anæmic or sickly person, and the probability of the spontaneous healing of a gastric ulcer becomes even more remote. The mild sepsis, both of the mouth and the stomach, on which Mayo Robson lays such well deserved stress, finds here its field of activity. The longer such lesions remain unhealed, the longer time will be required for their repair by medical means; recurrence after medical "cure" is frequent, and even surgical operations are not sure preventatives of recurrence, since they at most place the patient in the same condition with respect to future gastric ulcers as he was before the developement of the ulcers for which the operation was done.

When an ulcer has once formed in the stomach it is liable either to become callous, or to give rise to the acute complications of hemor-

rhage or perforation. As far as duration alone is concerned, it soon becomes a chronic ulcer whatever its special characteristics may be. But it is not always possible merely by looking at an ulcer to determine its duration; and where several ulcers coexist, it is often manifest that some of them are much more recent than others. Nor does the duration of the clinical symptoms always decide upon the age of the ulcer. It is frequently impossible to tell which one of several ulcers has caused symptoms the longest. An ulcer may have been latent for a considerable period before producing symptoms, or may have become quiescent some time since, and the recent symptoms may have been caused by a more recently developed ulcer, or by one which, though present for a long time, only recently has become symptom producing. As a rule, however, it is safe to assume that an ulcer with callous edges, and with its margin shelving, rather than punched out, is an ulcer of long duration—possibly ten to fifteen years; while an ulcer resembling in character the "erosion" of Dieulafoy is manifestly of quite recent formation. The "acute round ulcer," which appears cut out of the stomach wall, is of indefinite duration, and while we can say that it probably has not existed so long as an ulcer with callous margins, we cannot be certain, except from the patient's clinical history, that it has existed longer than a few months or even weeks.

This punched out ulcer is still actively ulcerating, and has not as a rule commenced to granulate to any appreciable degree. Its base is usually formed by the muscularis of the stomach wall, and as it is unprotected by granulation tissue, it is much more prone to perforate than is an ulcer of the callous type. And when perforation takes place in this punched out ulcer, the peritoneal cavity is usually at once involved, and the stomach contents escape into the general belly cavity unchecked by adhesions. A callous ulcer, on the other hand, has its base covered with granulations. Its base, but more especially its margin, shows the result of long-standing reactive inflammation, and the stomach walls are correspondingly thickened. Hence perforation in this type of ulcer is much more unusual than in the acute round ulcer, and when perforation does occur, the base of the ulcer is frequently adherent to some neighbouring organ, particularly the liver

or the pancreas, or is so protected by adhesions to the intestinal tract or the omentum, that general infection of the peritoneum rarely occurs at once. The formation of a subphrenic or subhepatic abscess, or an empyema of the lesser peritoneal cavity, very frequently in these cases precedes generalized peritoneal infection, and renders possible the application of surgical measures in time to prevent the latter complication.

The erosions seem more apt than other forms of ulceration to give rise to sudden and overwhelming hemorrhage, appearing as the first symptom of gastric ulceration, and at times leading to rapid death. The bleeding is in the nature of a general venous ooze. The punched out ulcer gives rise to acute and recurring hemorrhages, by ulcerating into a blood vessel. The bleeding is as a rule safely checked by medical means, but operation is indicated to prevent a recurrence of this alarming feature. The callous ulcer is the variety which produces, more frequently than any other, those occult hemorrhages which induce the severe anæmia not unfrequently encountered in this disease.

In form, the punched out ulcer is generally well described by its usual name of round ulcer, while the callous ulcer is more or less irregular in outline, sometimes appearing as if formed by the coalescence of several smaller ulcers, and usually having its longest axis transverse to the long axis of the stomach. It is this form of ulcer which is chiefly productive of gastric distortions, such as pyloric stenosis and hourglass stomach.

Symptoms.—The symptoms of gastric ulcer may be conveniently studied as those present in a patient with open ulcer; those occurring when hemorrhage is a marked symptom; those of perforation; and finally those due to contraction and adhesions of the ulcer.

Open ulcer, which, as has already been remarked, is a preferable term to acute ulcer, is that form of the affection which of all others is characterized by *pain*. It should not, however, be taken for granted that no ulcer exists when pain is absent. As previously noted, an open ulcer may remain latent until its presence is announced by hemorrhage or perforation. But the pain when it does occur is sufficiently characteristic to make it necessary for the physician to give it his careful attention. When the stomach is empty there is rarely

any pain, but very soon, sometimes immediately after food is swallowed, a soreness or a sharp stabbing pain will arise at some well-defined spot in the epigastrium; and this soreness will persist, and probably grow continually worse, until the stomach is emptied, either by vomiting or by the discharge of its contents into the duodenum.

It is impossible to decide from the site of pain or from the time after the ingestion of food at which it first appears, in precisely what region of the stomach the ulcer is situated or the condition of the ulcer. The cause of the pain is at present a much disputed question. Although the nerve supply of the stomach is largely derived from the pneumogastric nerve, which carries both sensory and motor fibres, many investigators and operators claim that there is no sensation in the stomach itself. Mansell Moullin asserts that the pain is not due to irritation of sensory nerves in the stomach, because, he claims, it has none. The pain is caused, he says, by irritation of the sensory nerves of the parietal peritoneum by means of adhesions, by contact or merely by excessive peristalsis. If his assertions are true, the theory that an excess of hydrochloric acid present in the stomach causes the pain which immediately follows the ingestion of food, must be abandoned. Clinical experience teaches that pain which occurs immediately after the ingestion of food is a symptom of a more serious condition than is pain which is slightly delayed.

Accompanying the pain, and usually also present in the intervals between food, when pain is often absent, will be found a more or less well-defined and constantly located area of *tenderness* to pressure. This is usually in the costal angle, a little to the right of the median line, as it is under this portion of the abdominal wall that the pyloric area of the stomach is most frequently found. If the tender spot, which varies in size from a half inch to two or three inches in diameter, is found further to the left, it is probable that the ulcer is not close to the pylorus; while if it is toward the right costal margin, the lesion is very likely to be in the duodenum.

The pain is not unfrequently *referred* to some other region as well as to the epigastrium, particularly to the left hypochondrium and neighbourhood of the left scapula. But more frequently it is the tenderness that is referred, particularly to the dorsal region. Peculiarly characteristic is a tender spot to the left, more rarely to the right, of the

last two dorsal vertebræ. This sign is supposed to be more often due to an ulcer upon the posterior than to one upon the anterior wall of the stomach. Pain and tenderness which are referred are much less usual in these open ulcers than in those which have formed adhesions in the course of their cicatrization and contraction.

Vomiting, next to pain, is the most constant symptom of gastric ulcer. In open ulcers vomiting is often induced by the pain which the ingested food causes, and some patients will voluntarily produce emesis, by gagging themselves, merely to be relieved of their gastric distress. The act of vomiting may occur spontaneously soon after a meal is taken, but when it is a constant feature of the disease, it does not occur as a rule until at least a half hour or an hour after eating. The vomited matter is notably acid and malodorous, and is commonly streaked with blood. The vomiting is usually not repeated until after the next meal. Many patients will have nausea, but no vomiting.

Hæmatemesis may occur independently of the vomiting after meals at any time that the ulcer invades a blood vessel. Profuse and prostrating hemorrhage may occur as the first stage of gastric disease, and is then often due to one form of the erosions described by Dieulafoy, being a venous flow whose precise origin is rarely discoverable either at operation or autopsy. The possibility of there being varicosities in the stomach or œsophagus should not be overlooked. When the hemorrhage is in more moderate amount, but repeated at intervals of days, weeks, or months, it is especially significant of the acute round ulcer (open ulcer). Any sudden increase in arterial tension may give rise to such a hemorrhage. The process of digestion, with the accompanying increased activity and hyperæmia of the stomach, is naturally the most frequent cause; but sudden excitement, straining at stool, and vomiting, will all act in the same way. It is rare at night when the stomach as well as the whole body is at rest. Vomiting of arterial blood is present, according to most observers, in from 30 to 50 per cent. of all cases of gastric ulcer; and minute traces of blood can usually be found in the vomitus in about four-fifths of the cases. Although it is the round open ulcer that is particularly characterized by vomiting of arterial blood, yet this symptom may be

present in the healing ulcer. In the latter form, however, the blood is usually much less in quantity, and is more frequently clotted before it is vomited. Hemorrhage, as well as vomiting, are later signs of gastric ulcer than is pain.

Hemorrhage into the stomach in cases of gastric ulcer does not always produce immediate vomiting. The blood may lie in the stomach and before vomiting occurs may become clotted or intimately mixed with food which has been ingested subsequent to the occurrence of the bleeding. Or the blood may be passed into the intestines and be finally evacuated in the stools, in which case it is much more liable to be overlooked.

A consideration of hemorrhage leads naturally to a discussion of the *anæmia* which has for so long been regarded as a characteristic feature of the open gastric ulcer. It is still an undecided question whether the typical anæmia is a cause or a result of the disease; but it is at any rate certain that it is a fairly constant feature, and opinion at present is inclined to consider both the anæmia and the gastric ulcer as produced by the same cause—toxæmia. Particularly in young females is this anæmia noticed. A growing girl or a young woman who is anæmic and has indigestion should be very carefully examined for evidence of gastric ulcer. The anæmia is usually of the chlorotic type—that is to say, there is a decrease in the number of the red blood cells, and a still greater decrease in the amount of hæmoglobin present; the cellular elements being more quickly replaced after hemorrhage than is the hæmoglobin. Inanition due to the vomiting and to the impaired digestive powers of the individual, as well as the recurring hemorrhage from the ulcer itself, are important factors in maintaining an anæmia which has once developed.

Besides the three cardinal symptoms of gastric ulcer—pain, vomiting, hemorrhage—and the anæmia which is such a constant feature of the disease, there are other signs which are of considerable value in making a diagnosis. *Hyperacidity* of the gastric secretion is one of the most important of these additional signs. It is not within the purpose of this volume to treat of the technique of the examination of the stomach contents; a full description of the apparatus required to

obtain them, the manner in which it is employed, the test meal used by us, etc., will be found at p. 60.

The stomach normally empties itself in from four to six hours after an ordinary meal has been eaten. With increased gastric motility, which is generally present in open gastric ulcer, the time required by the stomach to empty itself is at times markedly decreased. This is especially true if the meal contains a large proportion of meat.

As a rule *no mass* can be detected by palpation in cases of open ulcer. In long-standing ulcers, attended by much thickening and many adhesions, the presence of a mass is not so rare.

Hemorrhage in Ulcer of the Stomach.

As a general statement it may be said that any of the pathological varieties of ulcer may be the origin of any form of hemorrhage—of a sudden and fatal flow of blood, which kills in a few minutes; of repeated hemorrhages alarming in quantity but not immediately lethal; or of occult hemorrhages only to be detected at times by persistent and painstaking microscopical examination of the vomitus and the fæces. But as a rule those hemorrhages which occur as the first symptom of ulcer, and which quickly kill the patient by their mere quantity, are found to have their origin in erosions of the mucous membrane, and not from any well-defined artery. This is the rule, and if we could know that such a form of ulceration existed, we should expect any hemorrhage which might occur to be profuse and overwhelming in quantity and to be quickly fatal.

Bleeding, more moderate in amount, though perhaps still alarming at times, but which ceases before the patient is entirely prostrated, and again recurs in similar amounts at irregular intervals of a few weeks or months, is the form of hemorrhage which is specially characteristic of the round open ulcer. In such cases the ulceration in its progress opens some medium sized arterial twig, and free hemorrhage occurs until retraction and contraction of the opened vessel allow its mouth to be closed by clotting. Venous twigs are more rarely opened

by these ulcers, possibly because the current of blood in them is slower, the tension less, and clotting occurs before or as soon as the vessel is opened. When repeated vomitings are merely streaked with blood, the hemorrhage has probably arisen in some such way as this. The callous ulcer has as its characteristic form of bleeding the "occult" hemorrhage already mentioned. The area of the stomach affected is in these cases anæmic, being very largely formed of scar tissue, and any bleeding that occurs usually comes from some abrasion of the stomach wall consequent upon the stenosis present, or else arises from some portion of the cicatrizing area which has not yet entirely healed. But if, in this form of ulceration, a blood vessel of any size is perforated, the very thickness and rigidity of the margins of the ulcer, which were, before, the patient's protection against hemorrhage and perforation, become now his destruction, since they absolutely prevent retraction and contraction of the opened vessel, and bleeding continues until the patient is dead. It is by such a process as this that the splenic or hepatic artery or one of their branches occasionally is perforated, the chronic ulcer having long since contracted adhesions to the pancreas or its surrounding structures, and the artery being fixed in a vise of cicatricial connective tissue.

Hemorrhage from an ulcer of the stomach is not always manifested by vomiting. In some cases of profuse hemorrhage the patient suddenly turns pale, becomes giddy, gasps for breath, is exceedingly thirsty; his pulse becomes feeble and rapid, his stomach feels full and warm, and syncope may be followed by death without further warning. If the bleeding be less profuse, and still no vomiting occur, life may be prolonged for a couple of days, the patient presenting, after the symptoms of internal hemorrhage, those of mild sepsis, with fever and delirium. Black spots may float before the eyes, or the amblyopia may be complete.

The more profuse the hemorrhage, the more apt it is to be due to ulcer, and not to carcinoma or to portal congestion or gastritis. In these latter conditions the amount of blood lost is rarely more than a few ounces, and usually clots before being vomited; but a pint or more is not unfrequently lost in cases of ulcer. After a hemorrhage of even less amount, the patient may present the

signs of secondary anæmia for some weeks. Dyspnœa may occur on the least exertion; the extremities may remain cold and clammy; tinnitus aurium may be an annoying feature; restlessness or even delirium may disturb the sleep. Irregular fever may persist in some patients for many weeks. This symptom, although always arousing suspicions of perigastric abscess, may be due to mild sepsis from a sloughing ulcer, which even a successful gastro-enterostomy cannot relieve at once, or may possibly be merely an evidence of the severe secondary anæmia.

Perforation of Gastric Ulcers.

This serious complication, which is said to occur in about four per cent. of all cases, and to constitute eighty per cent. of the deaths due to the disease, arises from various and rather ill-defined causes. As in the case of hemorrhage, so also a perforation may be inaugurated either by physical means, or by the pathological processes of ulceration or sloughing. When an acute ulcer is subjected to sudden strain, as in vomiting, or is abraded by ingested food, its base may give way, and the peritoneal cavity be opened. Chronic ulcers are not so apt to be affected in this manner, partly because of the thickness of their bases and margins, but more especially because perigastritis usually has existed for some time, and as a consequence the general peritoneal cavity is protected by adhesions. Adhesions are said to form in about two-fifths of the cases of perforation. When, in an acute ulcer, the perforation arises from the physical causes just mentioned, the solution of continuity is frequently slit-like in character; but when due to the extension of the ulcerating process, or to sloughing, the perforation is more or less circular. It is generally found that the larger perforations are due to the separation of a slough, and that those produced by progressing ulceration are minute in size, and give rise to symptoms less acute than the other varieties of perforation.

Perforations vary by actual measurement from those which can be classed merely as pin-point to those which will admit two or three fingers and measure two or three inches in diameter. The average

perforation, however, does not exceed a quarter or a half an inch in diameter.

As a rule there is not more than one perforation present; but in about twenty per cent. of cases two or more have been found; hence it is always well to search the gastric surface thoroughly, and in cases of doubt to establish free drainage of suspicious regions.

Since it makes a very considerable difference not only in the initial symptoms but also in the facility of subsequent treatment, whether the perforation be on the anterior wall of the stomach, and easily accessible, or near the fundus, or on the posterior wall, it is very important for the surgeon to be familiar with the usual sites of perforation, and with the clinical course pursued by the ulcer in each case.

The statistics collected by various investigators show that although gastric ulcer occurs most frequently on the posterior wall of the stomach, yet that perforations occur with greatest frequency on the anterior wall. This difference is well seen in the tables published a few years since by A. P. C. Ashhurst.

TABLE I.—SHOWING SITE OF GASTRIC ULCER IN GENERAL.

Author.	Anterior Wall.	Lesser Curvature.	Posterior Wall.	Pylorus.	Fundus.	Cardia.	Anterior and Posterior Walls.	Greater Curvature.	Total.
Brinton.....	10	56	86	32	0	4	13	5	206
Welch.....	69	288	235	95.	29	50	0	27	793
Per cent.....	8	34.4	32.1	12.7	2.9	5.4	1.3	3.2	$\frac{999}{100}$

TABLE II.—SHOWING SITE OF PERFORATED GASTRIC ULCERS.

Author.	Anterior Wall.	Lesser Curvature.	Posterior Wall.	Pylorus.	Fundus.	Cardia.	Anterior and Posterior Walls.	Greater Curvature.	Total.
Bidwell.....	36	3	8	0	0	0	1	0	47
Comte.....	28	4	8	3	0	0	0	0	43
Per cent.....	71.11	6.67	17.78	3.33	0	0	1.11	0	$\frac{90}{100}$

As Ashhurst remarks, "although the numbers in the second table are less than one-tenth of those involved in the first, yet the

difference in the result is so great that the relation could scarcely be materially disturbed, even were the number of perforations recorded to equal that of the total number of ulcers observed." The reason for this difference lies not in any difference in the ulcers themselves, but in the relations of the stomach to surrounding viscera. The anterior wall of the stomach is exposed to the general peritoneal cavity, is subject to a greater degree of dilatation and contraction than is the posterior, and is also more exposed to external trauma acting through the abdominal walls. The posterior is placed in contact with the relatively rigid and immovable spinal column, within the limited confines of the lesser peritoneal cavity, and in close relation with the pancreas, duodenum, and Spigelian lobe of the liver. Being thus protected, ulcers on the posterior gastric surface are prone to induce perigastric adhesions as soon as any peritoneal irritation is developed, and being so reinforced are neither so apt to perforate, nor to produce diffuse peritonitis in the rare event of their actual perforation, as are those placed in less well-protected situations. The location of gastric perforations is well shown in Figs. 16 and 17.

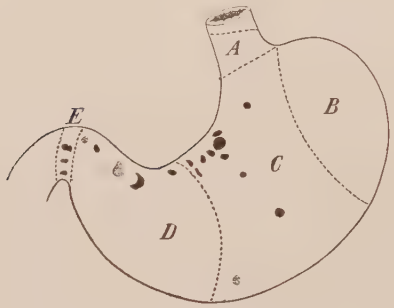

Fig. 16.—Diagram Showing Sites of Perforated Gastric Ulcers.

A, cardia; *B*, fundus; *C*, body of stomach; *D*, pyloric portion; *E*, pylorus. Perforations on the posterior wall are indicated by lighter shading.

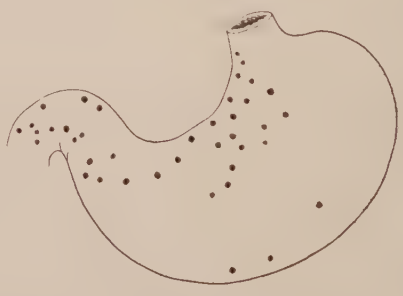

Fig. 17.—Diagram Showing Sites of Perforated Gastric Ulcers.

Perforation of gastric ulcers has been well described as *acute*, *subacute*, or *chronic* in character. These terms refer not so much to

the symptoms produced, as to the pathological course of the peritonitis caused by the perforation. An ulcer which perforates acutely is one such as those on the anterior wall which bursts through into the peritoneal cavity by sloughing or from the effect of physical forces, without having previously set up by contiguity a limited plastic peritonitis sufficient to protect, for a time at least, the general peritoneum from invasion. An ulcer which perforates subacutely is one whose base is gradually ulcerated through, so that perigastritis with its premonitory symptoms precedes the actual solution of continuity; and so that when this solution of continuity occurs, there is either a spreading plastic peritonitis already inaugurated, or adhesions are present which are more or less capable of limiting the outflow of the gastric contents. By the term chronic perforation is indicated that process which ensues when the base of an ulcer is adherent to some neighbouring organ, so that practically no additional symptoms are produced at the actual moment when the gastric wall ceases to form the floor of the ulcer, and its place is taken by pancreatic or hepatic tissue, or by firm fibrino-plastic material—so that, in short, the symptoms which first call attention to the changed condition are not those of perforation nor peritonitis, but of sepsis, induced by slow absorption from some variety of perigastric or subphrenic abscess.

Subphrenic abscess (p. 443) has as its most frequent cause gastric ulcer. Indeed, the more we learn of the upper abdomen, the rarer seem to become the cases of subphrenic abscess found in connection with any other disease, such as cholecystitis, appendicitis, or suppurative hepatitis. The term subphrenic abscess, so indiscriminately used, is in many instances a misnomer, since the purulent collection is frequently subhepatic or retrocolic in location, and bears no direct relation to the diaphragm. When arising from a perforation on the anterior wall of the stomach, the abscess is usually found beneath the left lobe of the liver; and if it extend forward may come finally into direct contact with the parietal peritoneum of the anterior abdominal wall. *Perigastric abscess* as a result of an ulcer on the anterior wall of the stomach is a rather unusual occurrence, and when found, the ulcer is nearly invariably placed close to the lesser curvature of the stomach. Under these circumstances the stomach wall forms the lower wall of

the abscess cavity, the gastro-hepatic omentum its posterior boundary, while its roof is formed by the left lobe of the liver, and its anterior wall by adhesions, or possibly by the omentum. If the perforation occur toward the fundus of the stomach, the spleen may form one of the boundaries of any abscess that forms; while if near the cardiac opening a true subdiaphragmatic abscess may result. In rare cases a perigastric abscess on the anterior wall has been known to perforate the colon, forming a gastro-colic fistula. The duodenum and the gall-bladder may also be perforated.

On the posterior surface of the stomach perigastric abscess may occupy any of several not very unusual positions. Even when the ulcer is situated near the lesser curvature it has been found to form adhesions to the liver only one-third as often as it does to the pancreas. Occasionally the whole of the lesser peritoneal cavity becomes involved, forming an empyema of the bursa omentalis. The general rule for the extension of these abscesses is that they tend to enlarge most in the direction of that portion of their walls which is formed by adhesions. If the abscess is in relation with the pancreas or the duodenum, it is not apt to extend into the substance of the one nor to perforate the lumen of the other even if their surface be penetrated; though either event may occur in rare instances. But when the liver forms one of the boundaries of a perigastric abscess, its soft and friable texture, in marked contrast to the fibrous structure of the pancreas, offers very slight resistance to the purulent invasion when once the capsule of Glisson has been penetrated. If the abscess extend posteriorly without invading the liver substance, it will work its way up between the Spigelian lobe and the crus of the diaphragm, and become in reality a subphrenic abscess. In this situation the sinuous course taken by the pus in the effort to evacuate itself is sometimes truly remarkable. The pericardium may be entered after perforation of the diaphragm, causing sudden death, as in the case narrated by Fenwick; the pleura may be invaded, producing pyopneumothorax, as in cases recorded by Bidwell, Mackenzie, and others; or the anterior or lateral abdominal walls may be reached by such devious and circuitous routes as almost to elude detection.

Symptoms.—The initial symptoms of perforation of any portion

of the digestive tract bear a family resemblance to each other, and it is mainly by attention to the previous history of the case, and to certain rather ill-defined differential points, that a decision can be reached as to the particular part affected.

Sudden, severe, burning *pain* is nearly invariably the first symptom. It is usually localized in the epigastric or umbilical region, showing no tendency to shoot from one portion of the belly to another, nor to be referred to the hypochondriac or scapular regions. The pain is frequently so severe as to compel the patient to cry out; it affects him like a cramp: he doubles up his thighs toward his abdomen, and bows his body to his thighs, pressing his hands into his belly. Any one who has watched even one of these patients will never forget the sight. This agonizing pain may persist for fifteen or thirty minutes; ordinarily it is quickly succeeded by symptoms of collapse. The collapse, recognized by the anxious cast of countenance, the cold and clammy surface, the sudden pallor, the guarded breathing, and the quickening, feeble pulse, is probably due to the escape of air from the intestinal tract into the peritoneal cavity. That it is not due merely to the presence of air within the peritoneal cavity is abundantly proved by the absence of such symptoms when the peritoneum is widely exposed to the air during operations even without general anæsthesia. (See p. 124.) The change in blood pressure produced by the sudden transference of air from within the intestine or stomach to the peritoneal cavity surrounding them, seems to produce an immediate constitutional effect through the sympathetic nerves; and this effect is what we call *shock*. This, then, is the state which ensues very soon after the initial pain has made its appearance. When shock is fully developed, the senses are so obtunded that pain is no longer recognized as such, or at the very least its character changes, and it becomes less unendurable.

After the first onset of pain, the patient often—in from fifty to sixty per cent. of cases—vomits, but this act is not commonly repeated, thus giving us one important point of distinction between perforation and obstruction or strangulation of the bowel. *Vomiting* is a serious feature, since it forces the stomach contents out not only by way of the œsophagus, but also through the perforation into the peritoneal

cavity. If the stomach be empty at the time perforation occurs, the nausea will produce retching only, and at most a little fluid, occasionally blood stained, will be vomited.

Not until peritoneal reaction has commenced does marked *rigidity* of the abdominal wall appear. If the infection be overwhelming, it may never appear, but the patient will sink under the lethal influence of the toxic peritonitis, without an effort at repair of the lesion by plastic exudation. *Tenderness* arises at the same time as rigidity. The patient will no longer feel the pain as a cramp-like affection; he will draw up his thighs so as to relax the abdominal muscles, and will protect his belly from the slightest pressure. The tenderness thus developed may persist after extensive peritoneal involvement with its consequent tympany has rendered rigidity inappreciable. Of the two symptoms, however, rigidity is the more positive.

Thirst is a very frequent symptom of gastro-intestinal perforations. Although nausea be present, and even if the initial vomiting be repeated, the patient will be very apt to drink water time and again, in the vain effort to relieve his thirst. During the height of the attack the *urine* is scanty or altogether suppressed.

The escape of air into the peritoneal cavity may in some instances be so great as to cause a diminution or an actual obliteration of the *liver dullness*. This is, however, a sign on which absolute reliance cannot be placed. Extreme tympany without any perforation may produce similar physical signs, and even when a large amount of air is free within the peritoneal cavity the liver dullness may persist.

If free air be present in the peritoneal cavity under even slight pressure, it may be detected by means of the coin test so frequently used in the diagnosis of pneumothorax. If one coin be placed on the abdominal wall and struck by another coin, the presence of air within the abdominal cavity will be revealed by a clear metallic sound, distinctly heard through a stethoscope or by the ear held on the abdominal wall near the coin. If the area of metallic sound be not circumscribed, as it would be if the air were within the stomach or a portion of the intestinal tract, free air within the peritoneal cavity can be diagnosticated, and this sign is claimed by many to be pathognomonic of perforation of the gastro-intestinal tract.

Emphysema of the subcutaneous tissues, a very unusual symptom, was first noted in a case of gastric perforation by Demarquay (1866).

Immediately after perforation of any portion of the gastro-intestinal tract, the *temperature* is apt to fall. We attach considerable importance to this symptom, and believe that if the temperature were taken without fail immediately after the initial pain appeared, it would be found subnormal with greater regularity than the statements of some writers would lead one to believe.

Accompanying or closely following the fall of temperature, there is a quickening of the *pulse;* and if operation be not undertaken promptly, the local tenderness and rigidity will spread over the abdomen.

Diagnosis.—Acute, overwhelming pain, vomiting, fall of temperature, rise of pulse, shock, and peritoneal reaction—these are the symptoms of perforation into the peritoneal cavity in general; and, as was remarked in the beginning, it remains to determine in the presence of these, what portion of the gastro-intestinal tube is affected.

In anæmic young women the surgeon's thoughts would naturally turn to gastric ulcer as the cause of the perforation, and ninety-nine times out of one hundred he would be correct, even in the absence of a history of gastric disease. Such history usually can be elicited in over ninety per cent. of patients with gastric perforations. English found it present in forty out of fifty cases of gastric and duodenal perforation, no previous history of any kind being obtainable in five of the cases, and a previous history of gastric disease being absent in only five of the patients.

In an adult man, duodenal ulcers are more apt to be the cause of perforation than are gastric, and where no history is obtainable, that portion of the digestive tract should be explored first in such patients. Of course if there were a clear history of preceding gastric symptoms, it would be difficult for no one to make the diagnosis of gastric or duodenal perforation; but in the absence of such history there are no pathognomonic symptoms by which we can certainly distinguish between these two, or even between perforation occurring in the upper and that occurring in the lower portions of the abdomen. Those portions of the gastro-intestinal tract which most frequently perforate

are the appendix, the ileum, the stomach, and the duodenum; and the frequency of perforation is probably in the order named. But the appendix rarely perforates without some premonitory attacks, and even when it does perforate into the general peritoneal cavity, the symptoms produced are not of so alarming and prostrating a nature as when some portion of the digestive tube with a larger calibre is perforated. Perforations of the ileum are rare, except during typhoid fever; and the occurrence of symptoms of peritoneal perforation during typhoid fever would naturally suggest the ileum as the part affected. Typhoid ulcers of the stomach are extremely rare. (See page 70.)

In diagnosticating perforations of the upper abdomen, when the clinical history is negative, we must rely chiefly upon the location of the initial pain, and upon the directions in which peritoneal involvement proceeds. Although perforations in other portions of the abdomen sometimes produce epigastric pain, it is rare for gastric perforations to cause other than epigastric pain. Then, too, in gastric and duodenal perforations, the general peritoneal cavity is more quickly involved than in perforative lesions of the lower abdomen. In the latter it is the pelvis that is usually first involved by extension, and the umbilical and epigastric regions do not become affected until later; whereas when the perforation is in the stomach or duodenum, these regions are immediately affected, and it is only by gravitation of liquids that the lower portions of the abdomen are involved. In the majority of gastric perforations the transverse colon and the great omentum protect the hypogastric region and the pelvis from invasion, and as the splenic flexure of the colon is almost invariably higher than the hepatic, any fluid extravasated above it tends to flow toward the right. These facts, as well as the anatomical relations of the ascending mesocolon, tend to make fluids from perforations in the upper abdomen collect first in the right kidney pouch, and then in the right iliac fossa. When a patient presents such symptoms as these when seen for the first time, the resemblance to appendicular abscess is very close, and the diagnosis of gastric perforation is practically never made before operation, especially where no history of previous gastric disease can be elicited. Such cases have been recorded by Kammerer,

and by Harte who mentions the speed with which fermentative changes occur in the upper intestinal tract, and notes the consequent presence of gas in the peritoneal cavity (when the abdomen is opened) as a sign suggestive of the high location of the perforation.

In some instances, when the existence of a gastric ulcer is known, the onset of a subacute perforation may be recognized by premonitory symptoms for several days beforehand. Fleeting pain of a stab-like character, or merely vague feelings of increased gastric distress may be present; and cases are known where deep breathing or sudden turning of the body have caused exacerbations of the pain by a sudden pull on newly formed adhesions. Robson and Moynihan mention a patient who said that it hurt her to bend, as her side felt stiff. In cases such as these the moment of actual perforation is not attended by such violent pain nor by such marked collapse as when the perforation is acute; and a temporary lull may occur, during which the symptoms abate, and a perigastric abscess forms. Unless promptly relieved by operation such patients will perish from sepsis or from subsequent generalized peritonitis.

The symptoms of chronic perforations of the stomach are those of perigastric and subphrenic abscess. Strict attention to the clinical history of the patient, with a painstaking and if need be oft-repeated physical examination will enable the diagnosis to be made in the majority of cases. Evidences of sepsis, with progressive emaciation, hectic fever, chills and sweats, and, above all, persistent tenderness to pressure, will be the surgeon's best guide. Further consideration will be given this subject in a subsequent chapter. (See p. 442.)

Differential Diagnosis.—Although, with a clear history and characteristic symptoms, such as those already detailed, the diagnosis of gastric perforation may be considered an easy problem, yet in not a few instances mistakes have been made by capable surgeons. Even with symptoms so typical as to leave no reasonable room for doubt, abdomens have been opened, and yet no lesion whatever has been found, and the patients have gone on to satisfactory recovery. And in a somewhat less limited number of cases some lesion other than gastric perforation has been discovered either at operation or autopsy. The

importance of attentively considering the differential diagnosis of this complication is therefore very evident.

Perforation of duodenal ulcer is the condition which in every respect most closely resembles the perforation of a gastric ulcer. Indeed, so close is the resemblance that differentiation from symptoms alone is usually impossible, and the surgeon must rely on the age, sex, and previous history of the patient in drawing his conclusions. Since immediate operation is indicated in either case, and as the technique in both cases is practically the same, the distinction is in this instance of more academic than practical importance.

Though rare, it is not an unheard of thing for peritonitis to arise in gastric disease without any actual perforation. McCosh has recorded the case of a patient in whom strangulation of a gastric polyp produced *gangrenous gastritis*, with the formation of an abscess which gravitated to the right iliac fossa, and later caused death from general peritonitis. Harte has observed a case in which a *septic gastritis*, arising during an attack of acute nephritis, with uræmia, caused all the symptoms of a gastric or duodenal perforation, and in which death ensued from generalized peritonitis, no macroscopic perforation being discoverable at autopsy.

Acute appendicitis differs in several respects in the symptoms it usually presents, and as a rule need not be confused with a gastric perforation, especially if the latter be of the acute variety. Many cases of subacute perforation of the stomach resemble suppurative appendicitis very closely, and are frequently not to be distinguished until after the abdomen has been opened. In acute appendicitis the initial pain is diffuse, colicky, and wave-like in character; at a later period it settles into the right iliac fossa. There is little if any collapse; fall of temperature is rare; abdominal rigidity is well localized to the region of the appendix, and general peritoneal invasion is often delayed for one or two days, a palpable mass meantime forming in the right iliac fossa. The pain in acute gastric perforation is overwhelming, and though local at first, very quickly becomes general; the shock is profound, the temperature falls, and the patient appears in imminent danger of death; as reaction commences, evidences of general peritonitis are found, and at a much earlier period than is the case in appendicitis.

Ruptured extrauterine pregnancy resembles gastric perforation in the agonizing pain, the profound collapse, and the usual sex of the patient. But the previous histories are different; the location of the pain is not the same; evidences of internal hemorrhage frequently persist, and overshadow the rather tardy developement of peritonitis; and a vaginal examination may detect an exquisitely tender tumor in the pelvis.

Acute intestinal obstruction is not characterized by symptoms of peritonitis until strangulation occurs. Vomiting is persistent, becoming stercoraceous in time; rigidity is not pronounced, and relief from the pain may even be obtained by pressure and massage of the abdomen at a time long after diffuse peritonitis would have arisen were the case one of gastric perforation. Obstipation is absolute; collapse is wanting unless perforation occurs above the strangulated area, and the temperature remains normal or subnormal until the advent of peritonitis. The previous history of the patient may reveal the cause of the obstruction in long-standing peritoneal adhesions, or physical examination may detect a strangulated hernia or an ill-defined abdominal tumor—possibly a volvulus, an intussusception, or a pelvic tumor with twisted pedicle.

Gall-stone colic and *acute cholecystitis* are usually sufficiently distinguished by their clinical history, the location of their physical signs, and the absence of shock, with the slower developement of peritonitis.

Acute hemorrhagic pancreatitis resembles gastric perforation in the intensity of the pain and the profundity of the shock. No history of gastric ulcer is as a rule obtainable, however, nor does the affection occur in anæmic young females. The typical subjects of pancreatitis are obese, alcoholic individuals of middle life. There may be palpable, in the region of the pancreas, a deep seated tumor, which does not move with respiration, and which may reveal an indistinct sense of fluctuation. These features somewhat resemble those which arise in cases of perigastric abscess or empyema of the bursa omentalis, due to subacute or chronic perforations of gastric ulcers; and though some assistance in making the diagnosis may be obtainable by the possible occurrence, in pancreatitis, of jaundice, fatty diarrhœa, and glycosuria,

yet in many cases differentiation before opening the abdomen is impossible.

Mesenteric thrombosis is another affection which is sometimes confused with perforation of gastric ulcers. It is, however, a comparatively rare occurrence; and is not characterized by abrupt onset, shock, nor early peritonitis. Indeed, when the thrombosis is arterial, there are no well-recognized symptoms by which a diagnosis can be made, the affected bowel becoming the seat of dry gangrene. If venous obstruction arises, the symptoms are more acute; there are vague abdominal pains, continuous but paroxysmal; a little fever, possibly vomiting; sometimes bloody stools; and finally the evidence of peritonitis. But the course is much less acute than in gastric perforations, and all the symptoms less severe.

Ptomaine poisoning is characterized by a similar onset—acute abdominal pain, nausea, vomiting, and collapse. The collapse may be great, the temperature subnormal, and the skin cold and clammy. Diarrhœa, however, is often a salient feature, and the vomiting is more persistent than in cases of gastric perforation. Although the physical signs—tenderness, rigidity, and distention—are the same in both affections, distention occurs much earlier in ptomaine poisoning than when due to peritonitis from gastric perforation. In ptomaine poisoning, also, a history of the ingestion of suspected food stuffs can usually be obtained; and a period of incubation (varying from twelve to thirty-six or forty-eight hours) between the ingestion of the poison and the developement of symptoms will usually be found to have elapsed. During this period of incubation the patient may have been seemingly well, or there may have been fleeting pains in the abdomen, and more or less *malaise*. This distress, however, is intestinal, not gastric; and the history does not in the least resemble that of gastric ulcer.

Skin Diseases.—Certain affections of the skin, whose pathology is still very obscure, are at times attended by gastro-intestinal crises. This is particularly true of those affections belonging to the erythema group, and while they are more common in children, in whom gastric perforations are extremely rare, they are not unknown among adults. The occurrence of purpura, angeio-neurotic œdema, erythema, or

urticaria, with recurring colic, and often albumen in the urine, are the symptoms most significant of skin disease.

Cicatrizing (Chronic or Callous) Ulcer.—This form of ulcer is characterized less by acute pain and hæmatemesis than by persistent indigestion, melæna, which is often overlooked, and symptoms of obstruction of the pylorus. The vomitus may occasionally be streaked with blood, but the hemorrhage is rarely large in amount, except when fatal from perforation of some large vessel. The pain is not so marked as in open ulcer, the area of tenderness is not so well defined, and vomiting does not occur so soon after the ingestion of food. The pain is much more apt to be referred to some other region of the body, particularly to the left scapular region, and is more due to pulling upon adhesions than to irritation of the surface of the ulcer. Perforation is rare, and when it occurs is in the immense majority of cases either subacute or chronic in type, much more frequently producing perigastric or subphrenic abscess than immediate generalized peritonitis. A palpable mass is not unusual in a patient with a callous ulcer, and may sometimes closely simulate malignant disease. The most characteristic features, however, are those of dilatation of the stomach, with food stasis, and regurgitant vomiting—subjects which will be considered in detail in a subsequent chapter.

Diagnosis in Cases of Gastric Ulcer.—It scarcely seems necessary after the account of this affection just given, to dwell at any great length upon its diagnosis. Yet this is not always an easy matter, in spite of the succinctness with which the symptoms may be detailed. The clinical history of the patient is the feature of the disease which is most constant, and which must, in our judgement, take precedence over the physical examination, and over diagnosis by means of laboratory methods. Too little attention is commonly paid both by the family physician and the consultant to the importance of eliciting a clear and untrammeled account of the origin and progress of the malady from which the patient suffers. In cases of doubt, the attendant should return to the charge again and again, and should endeavour, without putting upon the patient's tongue any false answers, to obtain from him such responses as will, when strung together in chronological order, reveal the natural course of the disease. Very

many patients will have forgotten the earliest symptoms from which they suffered because they were ignorant of their significance; and it may not be until they have been questioned two or three times that some event, such as slight hæmatemesis, seemingly trivial in itself, will rise again to their memory, and perhaps supply to the history of the disease the missing link which so long had been desired.

The physical examination must be considered as merely confirmatory of the clinical history, as previously elicited; and any chemical tests of the stomach contents are of value only as corroborating the physical examination. Blood examination may further confirm the diagnosis by revealing a chronic anæmia. The presence of the normal leukocytosis during digestion favours ulcer rather than carcinoma.

Differential Diagnosis.—There are few affections with which a case of uncomplicated gastric ulcer need be confused. An exception to this statement is *ulcer of the duodenum*, which in many respects may so closely resemble gastric ulcer as to be indistinguishable. Its symptomatology is so fully considered under another section that it suffices here to recall the propriety of always having in mind the possible evidence of an ulcer in this region in any atypical case of supposedly gastric ulcer.

Acute gastritis and *gastro-duodenal catarrh*, while possibly productive of the symptoms of pain, tenderness and vomiting, are affections which may almost always be traced to some recent indiscretion in diet. The vomiting does not recur with any regularity after meals, in the effort to relieve the stomach of the pain which is present in cases of ulcer, but is the result of nearly constant nausea, which is characteristic of the inflammatory nature of the condition. The tenderness is diffuse, not accurately localized, as is usual in cases of gastric ulcer; hæmatemesis occurs only in the most exceptional cases; and jaundice, which is extremely rare in simple gastric ulcer, is a frequent accompaniment of gastro-duodenal catarrh. Finally, abstinence from food, with other appropriate treatment, quickly relieves the inflammatory affection, while the symptoms of gastric ulcer persist, or if cured temporarily are prone to recur as soon as energetic treatment is discontinued.

Hemorrhage from the gastro-intestinal tract due to other causes than gastric ulcer may be extremely difficult at times to differentiate from the latter affection. Particularly of hæmatemesis is this true. When the blood is discharged from the bowel, although duodenal ulcer should certainly be considered, there are usually other symptoms which will aid the diagnosis. Enterorrhagia is sometimes the earliest symptom of typhoid fever; it is not unfrequent as an early symptom of malignant changes in the bowel; but in both of these, as in almost every other conceivable case of bleeding from the bowels, there is almost invariably soon developed some other symptom or chain of symptoms which at once makes clear the nature of the malady.

Far different is the case with gastrorrhagia and hæmatemesis. It is natural to assume that a patient presenting these symptoms suffers from gastric ulcer; and when all other lesions have been excluded, the supposition seems justifiable. The confusion of hæmoptysis with gastric hemorrhage is not usual, and the difference in the physical signs between the gastric and thoracic disease, as well as the frothy character of the expectorated blood, tend to make such confusion, if it ever arise, rather short-lived.

A cause of sudden profuse hemorrhage which, until recently, has not received adequate consideration, is the rupture of varicose veins of the stomach or of the lower portion of the œsophagus. It is not improbable that some of the hemorrhages formerly attributed to erosions were in reality due to the rupture of varicose veins. W. J. Taylor gives a full discussion of this subject in an article published in the Transactions of the College of Physicians of Philadelphia for 1906. In many instances such varicose veins are a prolific source of gastric hemorrhage, unattended by evidence of disease elsewhere in the body. Preble collected sixty cases of fatal gastro-intestinal hemorrhage due to cirrhosis of the liver. Out of these sixty cases the œsophagus was examined in forty-two; and among these there were found œsophageal varices in thirty-five cases, or 85 per cent. The source of the hemorrhage, Preble states, was recorded in 19 cases, occurring 16 times from rupture or ulceration of œsophageal varices, twice from ulcers over gastric veins near the cardiac, and once from an erosion near the cardia. He thinks it probable that in many of the

cases in which varices were present minute ruptures had occurred which were overlooked, as they were not tested by injection with air or fluid. "The veins of the cardiac end of the stomach are part of the portal system, while those of the œsophagus are part of the systemic system. Here, as at the lower end of the intestinal tract, the two systems are connected by anastomosing branches which, as a rule, according to Orth and Kundrat, are too small or too few to contribute much to the formation of a collateral circulation when the portal system is obstructed. But when this anastomosis is free, they become an important factor, and their dilatation may so completely com-

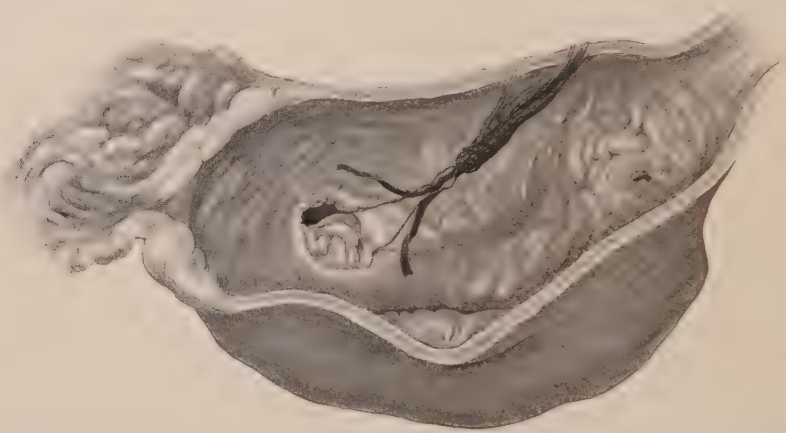

Fig. 18.—W. J. Taylor's Specimen Showing Rupture of a Varicose Gastric Vein Near the Cardia.

Note also gastro-jejunuostomy opening, and Pagenstecher thread hanging loose, with piece of undigested vegetable fibre attached.

pensate for the veins obstructed in the liver that the clinical course of the cirrhosis is altered and obscured" (Preble).

The blood in the lower œsophageal veins is returned to the heart by way of the lower azygos minor vein, as well as through some of the bronchial veins; and, as Preble points out, being intrathoracic in situation, they "feel the negative pressure of inspiration, while at the same time the pressure in the portal system rises to fourteen or even eighteen millimetres of mercury. In this way the blood is literally aspirated from the coronary into the œsophageal veins, and leads to their permanent dilatation."

In patients, therefore, where the anastomosis between the coronary and the œsophageal veins is free, cirrhosis of the liver may produce none of its usual symptoms, such as ascites, enlargement of the spleen and of the subcutaneous abdominal veins. Among the patients whose records were examined by Preble, in whom varices were present and caused hemorrhage, one-third died from hemorrhage without any accompanying sign of cirrhosis; in one-third hemorrhage was the first symptom, and others followed; and in the other third the hemorrhage was preceded by other symptoms.

The surgeon, therefore, should be very cautious about undertaking operations on the stomach in the case of a patient who presents symptoms merely of gastric hemorrhage, without other evidences of ulcer. If the abdomen of a patient with œsophageal varices due to cirrhosis of the liver be opened, there will usually be found an increased amount of peritoneal fluid, and palpation of the liver may detect the true condition. Under such circumstances, probably the best course will be to suture the omentum to the parietal peritoneum, in the hope of relieving the œsophageal veins of some of their pressure. Certainly no relief can be expected from a gastro-enterostomy. In cases of post-operative hemorrhage we believe with Dieulafoy that the condition is generally due to a mild form of sepsis, and that in fatal cases one or more erosions or exulcerations could be found in the gastric or intestinal mucosa.

A distinction between open ulcer of the stomach and *gastric carcinoma* is not usually difficult; but in certain cases of callous ulcer with much thickening and many perigastric adhesions, the diagnosis is often a matter of considerable importance as well as difficulty, since the question of radical treatment is at once raised. The distinction will be fully discussed under the heading of pyloric obstruction (see page 133). The duration of the disease is the most important factor in differentiating a simple ulcer from a cancer; but it must not be forgotten that while carcinoma is typically abrupt in its onset, first manifesting itself after forty years of age, yet that it is not unfrequently implanted upon ulcer, and that a patient with an ulcer of many years' duration may have a carcinoma which has only recently developed, but whose course, unchecked, will be quickly fatal. The age of the

patient, moreover, is no certain guide as to the presence of cancer. As is well known, the gastro-intestinal tract is affected with malignant growths in younger patients than is any other region of the body.

Gall-stone colic and *cholecystitis* are usually sufficiently distinguished by the location of their symptoms and physical signs, as well as by the extreme irregularity of the attacks of gall-stone colic, which bear no relation whatever to the ingestion of food, and which recur with no persistence after each meal, as does the pain due to gastric ulcer. Moreover, in the intervals of biliary colic the digestion is apparently in perfect order, and pain is absent.

Prognosis.—The prognosis in cases of ulcer of the stomach may be considered under three headings: (1) Untreated; (2) Medical Treatment; (3) Surgical Treatment. It is, however, extremely difficult to obtain any accurate data as to the percentage of deaths and permanent cures under the first two headings; and even with surgical treatment we must acknowledge that it is still of too recent adoption for us to draw definitive conclusions.

It is not likely that a patient with an ulcer which produces symptoms of any severity will go untreated. But it must be remembered that many ulcers are latent, and first announce their presence by copious hemorrhage or lethal perforation. Van Valzah and Nisbet, as long ago as 1900, were able to find scattered through the literature fifty-eight cases of latent ulcer, the first manifestation of which was perforation.

But there are many patients in whom the symptoms of the disease are subacute in character, and persist for years, untreated, until finally some acute complication occurs, killing them, or at least bringing them very near death; or if no acute complication arises, the patients pass into the class of chronic gastric ulcer, with pyloric obstruction, gastric dilatation, or other more serious affections. Brinton gave the mortality from all causes in gastric ulcer as 50 per cent.; Lebert considered 10 per cent. a fair estimate; while Robson and Moynihan come to the reasonable conclusion that under medical treatment the mortality of gastric ulcer is at least 20 per cent. This mortality they divide between hemorrhage, which kills 5 per cent., and perforation, which kills at least 15 per cent. of patients with ulcer of the stomach.

When, in addition to these figures, we consider the other complications to which patients with gastric ulcer are prone, we begin to realize what an alarmingly serious disease it is, and how unsatisfactory medical treatment must be in a great many cases. Among other complications to which gastric ulcer may give rise must be considered, in addition to perforation and hemorrhage, pyloric stenosis, with its long train of maladies due to dilated stomach; hourglass stomach, and other results of adhesions and distortions; the transition of ulcer into carcinoma (see page 271); subphrenic abscess; and even progressive pernicious anæmia, which is dwelt upon in particular by Hemmeter.

That medical treatment may accomplish much in patients suffering from open ulcer no one can deny. The immediate mortality of the disease may probably be reduced to 10 per cent. by the best medical treatment. But the treatment must be methodical and energetic. No half-hearted measures will suffice. As Van Valzah and Nisbet say, "Expectant treatment is a great blunder, for simple ulcer in a vigorous adult has no 'innate tendency to heal,' and the grave accidents which are too often the heralds of coming death occur somewhat regardless of the age, the constitution, and the general state of nutrition. The treatment must in every case be immediate, methodical, and sufficiently vigorous to be effective. A compromise may mean death or irreparable injury."

To consider at present only the prognosis of open ulcer of the stomach, postponing that of the callous or cicatrized variety to another chapter; it seems to us that a rational point of view is the following: To adopt in every case energetic medical treatment, by which we mean rest in bed, with local rest for the stomach, procured by nearly total abstinence from mouth feeding for at least one week, while the patient's strength is supported by nutrient enemata. A very gradual return to normal diet must be insisted upon. Under appropriate treatment such as this, the acute pain, the tenderness, and the recurring hemorrhages of open ulcer can almost invariably be checked, and in a certain proportion of cases, smaller we believe than medical men as a rule admit, these patients will remain cured. Mumford and Stone have quite recently considered in some detail these questions,

and conclude that, of patients treated by medical means and apparently cured (averaging about 80 per cent. of the whole), probably one-half do not remain cured, but have relapses of the same disease, or have some new and more serious disease, such as gastrectasis or gastric carcinoma, engrafted upon the previously existing disease. Paterson has recently traced 72 patients who after medical treatment were discharged from the hospital wards as clinically "cured." The most recent cases had been discharged more than two years before the investigation of their condition was undertaken. He found that of these 72 patients, only 19 were permanently cured; the condition of 7 was doubtful; while 46 were either still suffering from the symptoms of gastric ulcer (being 40 in number), had submitted subsequently to operative treatment (5 patients), or had died from gastric disease. Thus less than 27 per cent. were permanently cured by the medical treatment instituted; and even if the uncertain cases be counted as cures, there still remain 64 per cent. of the patients uncured by medical treatment. Murdoch (1906) has reported more satisfactory results: he studied 32 patients who had been medically treated for chronic ulcer; of these, 3 could not be traced, and 2 had died (1 of aneurism, and 1 of gastric hemorrhage); of those who remained, 20, or 69 per cent., were cured three years or more after having medical treatment, 4 were much improved, and 3 were not improved by the treatment that had been adopted. In view of these facts, therefore, we are of the opinion, where the symptoms of open ulcer are not relieved after energetic medical treatment lasting for several weeks —probably three months should be the outside limit—or where the disease recurs more than once after being temporarily checked, that in such patients some more radical treatment is required than medicine today affords. To meet the same indications which are present when these cases are being treated medically, the surgeon offers other means. He offers a permanent solution of the difficulty, where the physician has only an imperfect and temporary solution available. The main indication in all cases of open gastric ulcer is to reduce the hyperacidity of the stomach. The physician aims to bring this about by suppressing gastric secretion by either

total or partial abolition of mouth feeding. Meanwhile the patient is given nutrient enemata. Now, while nutrient enemata are a means of treatment whose value is thoroughly appreciated by the surgeon, it is one whose value is very often overestimated. The painstaking researches of Edsall and Miller have shown that even under the best conditions patients fed only with nutritious enemata are slowly starving to death; that the rate of excretion in such patients always exceeds the rate of absorption. Nor is the secretion of gastric juice prevented by means of nutrient enemata; for repeated experimentation has shown that the presence of nutritious material even in the large bowel will reflexly stimulate the gastric glands, and the ulcer will thus be bathed in acid still. Yet patients who receive some food by the mouth do not do so badly as those who are entirely prohibited from this means of nutrition; a fact which is shown by the familiar statistics of Greenough and Joslin: Of 62 patients treated with no food by the mouth, 32 per cent. only were cured; while of 52 patients who received some food by the mouth, 44 per cent. were cured. It is true that the latter series, as pointed out by these authors, probably included the less severe cases; but even with such an allowance, the conclusion is irresistible that the absolute starvation to which the patients in the former series were subjected (notwithstanding their receiving nutrient enemata) had a direct tendency to delay or even prevent their cure, by depressing their recuperative powers. The patients who received no food by the mouth, moreover, remained a longer time in the hospital, on the average, evidently for the same reason —failure of recuperative power.

The method of relief which surgery offers these sufferers consists in some form of operation by which the gastric secretion is more or less permanently altered. The physiological results of gastro-enterostomy have been studied by Carle and Fantino, by Soupault, by Paterson, by Cameron, by Mintz and others. The reader who desires to examine their results in detail is referred to the original articles, references to which are appended (p. 129). More recently Katzenstein has studied its results by means of experiments on dogs. He ascertained: (1) That after gastro-enter-

ostomy of any kind both pancreatic juice and bile passed freely into the stomach; (2) This inflow of alkaline fluid into the stomach was continuous in the early period after operation, but later on the inflow was periodical only; (3) Some months after the operation, pancreatic ferment and bile were demonstrable in the stomach one and a half hours after eating flesh, but after taking fat or water they were found there after half an hour; (4) The results of these changes were diminution of acidity and of pepsin digestion. From these facts Katzenstein concluded that gastro-enterostomy exerted a curative effect on ulcer by diminishing gastric acidity, and he suggested that the arrest of carcinomatous growth sometimes observed after this operation might be due to the local action of the trypsin of the pancreatic juice. In applying to man any conclusions drawn solely from animal experimentation, we have always felt that great caution should be employed; but, as practically the same course of events has been observed clinically, the conclusions of Katzenstein seem to us worthy of acceptance. Even Hale White admits that the metabolism of the body is not materially altered by gastro-jejunostomy.

The choice of operation does not concern us here. It will be fully discussed under the head of treatment. What we desire at present to learn is the immediate mortality of surgical treatment, and the proportion of ultimate and enduring cures that we may expect.

We have seen above that under medical treatment the immediate mortality is from 10 to 20 per cent. The mortality of untreated cases may be estimated at from 20 to 50 per cent. Mumford and Stone have recently estimated the immediate mortality under the best medical treatment as at least 8 per cent. This is, if anything too low. Bulstrode's statistics for 500 cases of gastric ulcer treated medically from 1897 to 1904, gave a mortality of 18 per cent., and this reckoning included all cases, even the very mildest, on which no one has ever proposed to operate; so that if only the gravest cases were considered, the mortality under medical treatment would be enormously increased. It may be remarked in passing that the statistics of five or more years ago represent very accurately the

most modern results of medical treatment, since this has not changed appreciably in that time; whereas surgical figures show a constant progress, and statistics even four years old can no longer be considered representative of the best obtainable results. The surgery of the stomach is new—it is one of the newest things in surgery today; and while the figures about to be given are the most recent available, they cannot accurately represent the latest and therefore the best results. The average death rate for gastro-enterostomy, or for Finney's pyloroplasty, which are the operations most frequently employed in these conditions, is as low in the average at the present day, in the hands of competent surgeons, as five per cent.

STATISTICS OF OPERATIONS FOR BENIGN DISEASES OF THE STOMACH.

Operator.	Date.	Number of Operations.	Deaths.	Mortality.
Crile [15]	1908	56	1	1.7 per cent.
Czerny [1]	1902	83	4	4.8 " "
Deaver [2]	1900–1907	91	8	8.7 " "
Hartmann [3]	1903–1905	47	3	6.3 " "
Helferich [4]	1905	86	7	8.1 " "
Hochenegg [5]	1906	94	6	6.4 " "
Krause [6]	1906	55	5	9.0 " "
Mayo [7]	1906	307	19	6.2 " "
Morison [8]	1905	27	1	3.7 " "
Moynihan [9]	1906	334	21	6.2 " "
Power, D'Arcy [10]	1906	41	3	7.3 " "
Robson, Mayo [11]	1906	322	10	3.1 " "
Rotgans [12]	1906	---	--	5.0 " "
Schou [13]	1907	54	3	5.5 " "
Schloffer [14]	1906	53	2	3.8 " "

[1] Czerny: Petersen and Machol, Beitr. z. klin. Chir., 1902, xxxiii, 297.
[2] Deaver: Records of German Hospital, Philadelphia, to Jan. 1, 1908.
[3] Hartmann: Lancet, 1906, November 24.
[4] Helferich: Graf, Deutsch. Zeit. f. Chir., 1907, xc, 365.
[5] Hochenegg: Semaine Méd., 1906, October 31.
[6] Krause: Medical Press and Circ., 1906, Dec. 12.
[7] Mayo: Annals of Surgery, April, 1906.
[8] Morison: Brit. Med. Jour., 1905, ii, 777.
[9] Moynihan: Lancet, 1906, Nov. 24.
[10] Power, D'Arcy: Lancet, 1906, December 16.
[11] Robson, Mayo: Brit. Med. Jour., 1906, ii, 1347.
[12] Rotgans: Lancet, 1906, November 24.
[13] Schou: Zentralbl. f. Chir., 1907, No. 29, S. 866.
[14] Schloffer: Semaine Méd., 1906, xxvi, 219.
[15] Crile: Ohio State Med. Jour., 1908, iv, 80.

Although the statistics from general hospitals are by no means so good as those obtained by individual surgeons, yet they are bound to improve as the average surgeon becomes more skillful both in selecting his cases for operation, as well as in the actual performance of the operation itself. French reported from Guy's Hospital 47 gastro-enterostomies for benign disease, with 13 deaths, a mortality of 23.4 per cent.; while in St. Bartholomew's Hospital Gask found 6 deaths among 35 gastro-enterostomies for benign disease, a death rate of 17.1 per cent. The figures of some surgeons show an almost vanishing mortality: Mayo (1906) had a series of 167 gastro-enterostomies for all causes, with only 1 death. Mayo Robson had only 2 deaths among 112 posterior gastro-jejunostomies for benign disease in his private practice up to 1906. Moynihan, in the same year, reported 248 posterior gastro-jejunostomies for benign disease with only 2 deaths, a mortality of 0.8 per cent.; and there had been no deaths among the last 151 such operations. J. B. Deaver has reported a series of 40 operations for benign diseases of the stomach, with only 1 death (2.5 per cent. mortality); and has since then had a series of 70 operations with only 2 deaths, a death rate of 2.85 per cent.

It must be remembered, moreover, that the figures for the surgical side of the argument include not only operations done on stomachs comparatively slightly diseased, but also many operations done on stomachs very extensively diseased—dilated, distorted, or contracted —by chronic ulceration; that the resistance of such patients may be expected to be less than that of those in the class we are now considering, and that the operative mortality is constantly lessening as surgeons become more expert and as their experience increases. This progressive improvement is well shown in the figures published by Hartmann, with characteristic courage: His first series of operations, done while he was assistant to Terrier, comprised 21 gastro-enterostomies, with 5 deaths, a mortality of 23.7 per cent., a death rate which is practically the same as that reported by French as occurring in Guy's Hospital. Hartmann's second series of operations, embracing those done from the time he ceased to be assistant to Terrier until Jan. 1, 1903, consisted of 34 gastro-enterostomies, with 3 deaths, a mortality of 8.8 per

cent.; while his latest reported series, running from 1903 to 1905, including 47 gastro-enterostomies, with only 3 deaths, showed a mortality of 6.3 per cent. If, then, to these factors of improvement in the surgical treatment itself, we add that important one of resort to surgical treatment before the patient has become a physical wreck, the contrast between the success of surgical and the ultimate failure of medical treatment becomes even more marked. Hartmann gives the following interesting figures, which for the credit of physicians are not, we are happy to say, very recent. In cases of gastric disease seen and treated primarily by himself and his colleagues—surgeons—the mortality of operation was two per cent.; but in a series of cases which had been primarily treated medically, and which were later referred to Hartmann by their physicians, the mortality of operation was twenty-four per cent. The two series of cases included sixty patients. Kocher writes: "The majority of practitioners do not sufficiently realize what brilliant results are to be obtained by operative means in chronic affections of the stomach, commonly known as gastric catarrh. Not only can the numerous dangers of ulcerating affections of the stomach, such as hemorrhage, perforation, transition into cancer, be prevented, but the disease and its results may be so rapidly and certainly cured that the medical treatment of obstinate cases must be put in the background..... The pain in the stomach disappears immediately after the operation. This is the invariable rule.....The patient does not require to pay any further attention to the nature of his food. The vomiting disappears. The bowels become regular. Repeated investigation of the gastric contents shows that there is a progressive improvement in the process of digestion; hyperacidity diminishes; if too little acid is present, it becomes increased, a statement which is in accord with Steudel, Carle and Fantino, Kausch, Hartmann, Soupault, and Mintz." Such words as these, from a surgeon such as Kocher, who weighs well what he writes, and knows whereof he speaks, should be instilled into the mind of every medical man who has cases of chronic gastric indigestion under his care.

If the immediate results of surgical treatment are such as have been described, what are the ultimate results? Is this condition of improvement maintained? Are the cures permanent? A decision in figures is not in this instance so easily reached. This is true not only because of the difficulty, which always exists, of tracing hospital patients after operation; but also because the very recent adoption of surgical treatment for these patients precludes the possibility of most of them having post-operative histories of sufficient duration to be quoted authoritatively as ultimate results. Yet the following may be given as the results in patients who have been traced for from one to three years or more after operation.

END RESULTS OF OPERATIONS FOR BENIGN DISEASES OF THE STOMACH.

Operator.	Cases Traced.	Cured.	
Mayo, (1908)	234	189	80.7 per cent.
Moynihan, (1908)	247	211	85.42 " "
Czerny, (1902)	53	44	83.0 " "
Robson	96	89	92.7 " "
Deaver, (1900-1907)	64	49	76.5 " "
Deaver, (1905-1907)	31	26	83.87 " "
Paterson, (collective statistics)	116	109	93.9 " "
Helferich, (1905)	56	41	73.3 " "

Among Czerny's patients, 41 were cured, 3 were greatly improved, 6 had recurrence, and 3 had died of cancer. Among the seven patients of Mayo Robson who were not cured by the operation, cancer developed in 4, relapses occurred in 2, and in one patient the operation had not produced even a temporary relief of symptoms. Of the senior author's own cases, 64 of which were traced, 37 (58.0 per cent.) had absolutely no gastric symptoms after operation, and 9 (14.0 per cent.) were markedly improved; 6 (9.4 per cent.) were unimproved by the operation; 3 (4.7 per cent.) had been cured but had died of intercurrent disease; and 9 had died at varying intervals since leaving the hospital from the original gastric lesion (2 probably of cancer), or from some late complication (intestinal obstruction, vicious circle), indirectly caused by the stomach condition. Denéchau has recently reported his study of the end results of gastro-enterostomy for benign disease, in 104 patients, operated on by different surgeons. He found

"satisfactory" results in 54 per cent., moderately good results in 38 per cent., and bad results (no improvement) in only 7 per cent. of these patients.

Paterson has recently traced the subsequent history of 116 patients who had been operated on by gastro enterostomy at periods varying from two to nineteen years. He concludes that over 85 per cent. are completely relieved, and 7 per cent. almost completely relieved, thus giving less than 7 per cent. of cases in which the results were wholly unsatisfactory. He found, moreover, if from this series were excluded those cases in which the anastomotic opening was small or in which some mechanical appliance was used to effect the anastomosis, that the proportion in which the result had been completely satisfactory was 92 per cent. This is certainly a favorable showing compared to relapses in 50 per cent. or more of patients treated by medical means. And it is our candid opinion that these figures give a fair idea of the surgical practice of today—the statistics of a few years ago were not so good; those of this year are better than those of last, and those of next year will be better yet. Surgical treatment allows 95 to 98 per cent. of these patients to recover. Medical treatment allows 75 to 80 per cent. to recover. Surgery permanently cures practically every patient who recovers. Medicine permanently cures only 30 to 40 per cent. of its patients. Medical treatment is long and uncertain. Surgical treatment is rapid and sure.

We do not wish, however, to be understood as urging surgical intervention in every case of gastric ulcer. As has already been stated, medical treatment should always first be tried, and only when methodical and energetic medical treatment has failed to cure the patient, after it has been persisted in for a reasonable time, or when several temporary cures have resulted in ultimate relapses, only then, we repeat, is surgical treatment to be considered in patients with acute, actively ulcerating lesions. In ulcers such as these, it is mainly on account of the complication of hemorrhage that the surgeon's advice is sought. Perforation is universally acknowledged to call for surgical intervention at the earliest possible moment. But in regard to hemorrhage there is still dispute.

Prognosis in Cases of Gastric Hemorrhage. As was pointed out in connection with the symptomatology of gastric ulcer, there are several distinct varieties or types in which bleeding from gastric ulcers occurs. The hemorrhage may be profuse and overwhelming; in such cases it has usually been found to be due to a very small ulceration into an arteriole or venule. This form of hemorrhage is not readily amenable to surgical treatment, and usually subsides by medical measures, such as astringents, absolute rest, and the local application of ice. The truly alarming hemorrhages are those which are frequent and slight in amount, gradually sapping the vitality, and, because often undetected, causing a profound anæmia. Occult blood in the fæces may be the only evidence of this recurring bleeding. For the relief of bleeding such as this, medical measures are of no avail. The bleeding persists, the patient loses ground, becomes wasted, anæmic, thirsty, feverish. The descent may be easy, but it is so merely because it is gradual. It is none the less progressive and sure. What is lost is not regained, and the attending physician will realize, perhaps too late, that the decline into which his patient has fallen is not only irremediable by medical measures, but may even have reached the stage where the shock of an operation will kill. Surgery—successful surgery—cannot be done on patients who have no blood; and it is the physician's duty to learn before it is too late that only surgery can afford relief. And it can be said without any hesitancy whatever, that when such patients are operated on in good time they are restored to health and happiness with a regularity of success which is one of the greatest triumphs of modern surgery.

The other form of hemorrhage to which patients with open ulcer are liable, occurs more frequently than that just mentioned, and is characterized by the intermittent, and by no means regular, occurrence of hæmatemesis. The vomitus may at times be only streaked with blood, or there may be an attack of vomiting of nearly pure blood, occurring once in six weeks or two months, or even less often. In pronounced and recurrent hemorrhage the patient fails in health so rapidly that radical measures are as a rule willingly undertaken; but in the less severe cases of hæmatemesis the

strength may be partially regained in the intervals, so that the appearance of health is maintained for some time; and the patient, and the physician as well, is often deluded into thinking that occasional vomiting of blood, with annoying though rather mild indigestion during the intervals, is less of an evil than would be resort to a surgical operation. Could such persons know the uniformity with which such symptoms are relieved by an operation they would be eager for its adoption.

Case.—Mrs. S. W., aged 37 years, admitted to the German Hospital December 7, 1905. In June 1905 this patient had been treated in the medical wards of the German Hospital for severe hæmatemesis, having vomited 2000 cc. of nearly pure blood. She had also blood in her stools. Her hæmoglobin was 25 per cent. She did well under medical treatment, and refused operation when she became strong enough in our judgment to undergo one. She returned to her home, and lived in comparative comfort until December, 1905, when, after feeling uncomfortable and ill at ease for a few days, she suddenly vomited 1500 cc. of bright blood. She was at once brought to the German Hospital, and soon after admission, on December 7th, she vomited 2000 cc. of blood. She was nearly exsanguinated, but after receiving 3500 cc. of saline solution intravenously, appeared somewhat improved. Her hæmoglobin was 43 per cent. on Dec. 8th. By the 13th it had fallen to 31 per cent., in spite of energetic medical treatment. On December 16th, a posterior gastro-jejunostomy with no loop was done, and the patient stood the operation well. Two days later, however, on December 18th, she died of exhaustion, with no further bleeding from the stomach.

Evidently in this patient the operation was done too late to be of any service; she might as well have died without an operation. For as has already been remarked successful surgery cannot be done on patients who have no blood, and the case of this patient is a striking example of the truth of this statement, and teaches a useful lesson.

The **prognosis in cases of gastric perforation** depends almost entirely on the promptness and efficiency with which operative treatment is undertaken. The results of operation for this condition will be fully discussed under the subject of treatment (page

122); and it remains at the present time only to say a few words in reference to certain other circumstances which are held to bear some relation to the prognosis. C. Brunner lays stress on the influence exerted on the prognosis by the amount of hydrochloric acid in the stomach at the moment of perforation. The prognosis, he finds, is most favourable when the hydrochloric acid is most abundant, that is from one to one and a half hours after meals; since under these circumstances the gastric contents are less septic than immediately (one-quarter to one-half an hour) after meals, at which period of digestion the amount of hydrochloric acid in the stomach is extremely slight, and peritonitis therefore more likely. Of course perforation of an empty and nearly sterile stomach is so much the less dangerous. The very great fatality which attends perforation in cases of gastric cancer is to be explained, according to C. Brunner, by the septic nature of the stomach contents due to the absence of hydrochloric acid.

Treatment.—Having, in the previous paragraphs, attempted to show which cases of gastric ulcer should, and which should not be subjected to operation, it now becomes our duty to attempt to reach a decision as to what special form of operation is to be employed for the relief of the conditions already described. The technical details of the operations discussed will be found described in Chapter XIV.

Under the general term **gastro-enterostomy** (an anastomosis between stomach and bowel) may be included the operation of *pyloroplasty* and Finney's modification of the same, known sometimes by the cumbrous name of *gastro pyloro-duodenostomy*, as well as Kocher's lateral *gastro-duodenostomy*, and the many and various modifications of *gastro-jejunostomy*. Of these procedures there are only two—Finney's pyloroplasty, and gastro-jejunostomy—which in our opinion merit serious consideration. And inasmuch as the same operations are employed in other affections of the stomach, which will be described in subsequent chapters, it will be most convenient to discuss at some length, in the present place, the various inherent advantages and disadvantages of these operations. Pylorodiosis, or digital divulsion of the pylorus, performed by Loreta

in 1882, may be dismissed without further consideration in this connection. The question of its adoption in cases of hyperemesis lactantium is discussed in connection with that subject at page 139. Hahn's modification of the same operation, by digital divulsion without opening the stomach, may also be dismissed without further mention, both being operations whose futility and danger have long been recognized.

Pyloroplasty as modified by Finney (1902) is really an extension of the Heineke-Mikulicz operation. As Mikulicz stated before the Philadelphia Academy of Surgery, in 1903, the usual illustrations of pyloroplasty given in the text books do not accurately represent the operation, as the incision should be made much longer, so as to extend both into the stomach and the duodenum, and on the lower rather than the anterior wall of the pylorus, thus approaching very closely to the more elabourate operation proposed by Finney. The theoretical advantages of such an operation are many; the practical drawbacks are, at least so it seems to us, even more numerous and weighty. It is true that by this method the normal gastro-intestinal channel is not altered, the ingested food passing at once from the stomach into the duodenum, as in the natural state; it is true that the operation is not usually difficult to perform, and that the subsequent developement of regurgitant vomiting is very unusual if not altogether unknown; it may also be admitted that the enlargement of the pyloric end of the stomach so much in a downward direction will secure to the ulcerated area all the benefits which are now believed to result after lateral gastro-jejunostomy from the admixture with the gastric secretion of bile and pancreatic juice, and that Finney's operation will also render the evacuation of the stomach more easy than will resort to a simple pyloroplasty. But in spite of all these advantages, there remain in our opinion very serious disadvantages which have not as yet been overcome. In the first place the rate of mortality is higher than is that of gastro-jejunostomy, even in Finney's own hands. Finney (1908) reported 48 operations by his method, with 4 deaths (none directly due to the operation), a mortality of 8.3 per cent. Mayo in 1905 reported 58 operations by Finney's method with 4 deaths, a mortality rate of 6.9 per cent.

The ultimate results, moreover, have been less satisfactory than those of gastro-jejunostomy, except when the cases for operation have been very carefully selected. It is needless to say that it is this very selection of proper cases which is the most difficult part of surgery. The presence of scar tissue at the pylorus renders it unfit for plastic procedures; and the existence of dense adhesions makes the operation not only difficult but dangerous. It should be stated, however, that Finney lays great stress upon the importance of thorough separation of all adhesions, and even regards this step of the operation as a requisite for success; and it must be admitted that failure has probably in many instances resulted from neglect to carry out this injunction rather than from any inherent fault in the operation itself. The ultimate results in Finney's own hands appear to have been quite satisfactory; he traced 19 patients who had been operated on for open ulcer or for pyloric stenosis, and found that in none had there been a return of symptoms; of 7 dyspeptics traced, 4 were cured, 1 was improved, and 2 had died; 2 patients operated on for gastro-succorrhœa were improved; and of 6 neurotic patients traced, 2 were cured, 1 was improved, and 3 were not improved. Rutherford Morison (1905) traced 28 patients on whom he had operated by Finney's method of pyloroplasty: 12 were perfectly well; 10 had occasional attacks of stomach trouble; 6 patients had definite recurrence of the old symptoms, but 4 of those were permanently cured by subsequent gastro-jejunostomy. The average period of relief, he found, after Finney's operation, was between 4 and 5 years; and in the 4 patients in whom subsequently he did gastro-jejunostomy, the recurrence of symptoms was due not to contraction of the newly formed pylorus, but to fresh ulceration. Among Mayo's 58 patients there were only two (3.4 per cent.) secondary operations required, these being for chronic regurgitation of bile into the stomach through too large an opening; a record which shows that not only were his cases carefully selected, but that the technical details of the operation were carried out with scrupulous care. In our opinion it is an operation which should be limited to patients without marked pyloric stenosis, with good motor power, where perigastritis is

absent, and where the pylorus is not involved in cicatricial tissue. It will be seen therefore, that there are very few cases indeed in which we deem this operation advisable. Adhesions are nature's safeguard, and should be treated with respect. The surgeon who attempts the operation of gastrolysis will fail to secure relief in ninety-nine cases for the one case in which a cure results. Too often the breaking up of adhesions only causes the reformation of adhesions which are thicker and more dense. In not a few cases the adhesions are on guard over a threatening perforation or over one which had perforated before, subacutely or chronically. In such cases injudicious destruction of the adhesions may open up a perforation into the stomach which it may be impossible to close by suture, and in any event this procedure will subject the patient to the risk of septic peritonitis from the unexpected, and at times undiscovered, extravasation of gastric contents. The safer course is to perform a gastro-jejunostomy in a healthy portion of the stomach wall, and leave nature's barriers undisturbed. The more marked the pyloric stenosis, the more certain are the benefits to be derived from gastro-jejunostomy; and where the pylorus is much obstructed it is involved in cicatricial tissue, and is an extremely unsuitable site for direct incision and suture. Stitches do not hold well in scar tissue, and scar tissue does not lend itself so readily to an anastomotic operation as does normal serous tissue, both because of rigidity and of the lack of blood supply. Yet in cases such as those recently reported by Moullin, in which the pylorus was an obstructive factor without being ulcerated or the seat of cicatricial tissue, Finney's operation may prove of value.

Gastro-jejunostomy, on the other hand, has been proved by clinical experience, the true criterion of success, to fulfill most admirably the indications in the surgical treatment of gastric ulcer. The death rate immediately due to this operation is extremely low—varying from three to less than one per cent. in the hands of experienced operators, and averaging probably not much over ten per cent. in collective statistics. The main objection to the operation, as applied to the cure of open ulcer, without marked pyloric stenosis, is that the food-stuffs are in many instances prone to pass

out of the stomach still by way of the diseased pylorus rather than to escape by the newly formed anastomotic opening at the greater curvature; thus permitting the developement of a vicious circle. But where the pylorus is patent, this difficulty can be readily overcome by ligation of the pylorus, thus rendering the passage through the new opening easier for the stomach contents than it would be when the pylorus opposed no special barrier to their progress. If we accept the idea of Roux of Lausanne and others as to the curative value of the direct action of the duodenal secretions on open gastric ulcer, there will be no reason in seeking to occlude the pylorus. The discussion of the merits of the different methods of performing gastro-jejunostomy will be postponed to Chapter XIV.

There still remains for consideration the treatment of gastric ulcers by **excision**. Originally advocated by Rydygier, it is a method which quickly fell into disrepute, owing to its enormous mortality. But in the last few years it has again become popular with some surgeons (Maydl, Jedlicka, Ali Krogius, Rodman, Bréchot and others), chiefly on the ground that it acts as a preventative of carcinomatous degeneration, but also because it is claimed that excision of the ulcer, or even if necessary of the whole ulcer bearing area, obviates the occurrence of subsequent hemorrhage or perforation, calamities which are not entirely unknown even after subsidence of symptoms caused by a gastro-enterostomy. On the other hand the facts remain, that (1) the immediate mortality of excision is higher, being 5 to 10 per cent., instead of 1 to 3 per cent., in experienced hands, as it is in the case of gastro-jejunostomy; that (2), in the second place, gastric ulcers are frequently multiple, and while one or two may be removed, others are nearly invariably overlooked; that (3) even should all the existing ulcers be readily discoverable, their removal may be impossible without the performance of a gastrectomy of prohibitory extent; that (4) after the excision of the suspected ulcer or ulcers fatal hemorrhage and perforation have occurred from ulcers which were left (Billroth, Eiselsberg, Mayo Robson and others); and finally the question of the line to be drawn between benign and malignant affections of the stomach is sometimes very difficult if not indeed impossible to decide

by microscopical studies alone. This matter of malignant degeneration or carcinomatous implantation in gastric ulcers will be discussed at length in connection with the ætiology of gastric carcinoma; but it seems fair to conclude that microscopical errors may have been made in some instances where gastric ulcers have been said to have presented evidences of incipient malignancy, just as clinical errors have been committed in condemning to an early grave patients with large pyloric tumors seemingly characteristic of cancer, which tumors have gradually and quietly melted away after gastro-jejunostomy and other palliative operations. Such cases have been observed by Terrier, Bidwell, Deaver, Wallis, Eiselsberg, Robson, Demoulin and Tuffier, Moynihan, Pantzer, and others. Deaver's patient, operated on as a last resort by anterior gastro-enterostomy for a supposedly cancerous mass, is still in excellent health, more than six years after the operation. So that it seems not unreasonable to argue that a palliative operation might have been equally successful in permanently curing gastric ulcers which presented no outward signs whatever of malignancy. Yet Jedlicka argues very positively in favour of excision of benign ulcers. Following his late master, Maydl, he records, during the period from 1891 to 1904, 34 gastric or pyloric resections for benign disease, with 2 deaths, a mortality of a little less than 6 per cent. His microscopical studies (confirmed in most cases by Hlava) showed that of his patients whose stomachs were resected for gastric ulcer, supposedly benign, no less than 26 per cent. had commencing malignant degeneration. He points out, moreover, that of the 14 patients whose stomachs were resected between 1891 and 1901 for carcinoma, not one is alive now; whereas of the four patients whose stomachs were resected in the same time for supposedly benign disease, which was afterward however found by the microscope to be malignant, but in an early stage—that of these four patients, the first is well eight years after the operation, the second is well four years after the operation, the third is still too recent to count; and only *one* died of recurrence, and then only after two circular resections of the stomach. For single ulcers he advocates partial excision, and has employed in two cases elabourate plastic procedures on the stomach, the operations lasting one and one-quarter, and two and one-quarter hours respectively;

both patients recovered. For more extensive disease a pylorectomy or a cylindrical resection of the body of the stomach may be required. Jedlicka further quotes Ssapesko as having recorded several cases in which cancer developed in ulcers which had been treated by gastro-enterostomy five or six years previously; and Jedlicka argues from this that these deaths should be charged to the operation of gastro-enterostomy. Rodman has collected 130 cases of pylorectomy for ulcer, with a mortality of 6.9 per cent. Bréchot collected (1906) 32 cases of pylorectomy for benign disease, by various French surgeons, with 3 deaths, a mortality of 9.4 per cent. He is an earnest advocate of gastrectomy for benign disease, and because this teaching seems to us pernicious, we have been at some pains to examine his paper, and beg to call attention to some of its contents. Bréchot insists in the first place on the importance of the normal physiology of the duodenum; we grant its importance. He then asserts that exclusion of the duodenum as effected by gastro-jejunostomy materially impairs the digestive functions; this we deny, and as he brings forward no facts of value sufficient to support his assertion, it is perhaps unnecessary to call attention again to well known observations (Steudel, Carle and Fantino, Kausch, Hartmann, Soupault, Mintz, Katzenstein, etc.) which prove the contrary. Bréchot divides organic stenosis into: (1) Those forms caused by kinking, by pylorospasm without obvious cause, and by fibrous stricture; and (2) those forms caused by benign tumors, or ulceration and its products. For the first class he says the proper operation is restoration of the gastro-intestinal canal; we agree with him. For the second he asserts excision should be done; in the case of benign tumors we think he is right, for modern experience goes to show that few such tumors are clinically really benign; but in the case of stenosis from ulceration we still think that gastro-jejunostomy is to be preferred in all but exceptional cases. After again stating the dangers of persistent hemorrhage and subsequent perforation after gastro-jejunostomy, he urges the danger of carcinomatous implantation. In regard to hemorrhage and perforation, it may be said that the cases which have been observed are too few in proportion to the total number of operations performed to make these late results worthy of such serious con-

sideration; and in regard to carcinoma, it may justly be urged that gastro-enterostomy *does* cure the ulcer, and thus prevents the developement of carcinoma. After rehearsing all the failures after gastro-enterostomy, such as the vicious circle, internal hernia, volvulus, and peptic ulcer of the jejunum (all of which are now things of the past), Bréchot closes his essay with some statistics and case histories, which he claims are the justification of his conclusions. As recent statistics, he refers to 62 gastro-enterostomies by von Eiselsberg (reported by Clairmont) with ten deaths, a mortality of 16.1 per cent.; and opposes to these lugubrious figures a record of eight pylorectomies by the same surgeon, with two deaths; but when he perceives that the latter mortality is 25 per cent., he hastily states that the figures involved are too small to be significant. Then he tabulates thirty-one case histories, in which operations are recorded, there being four immediate and two remote deaths (13 per cent. mortality at least); and among the twenty-five who recovered from pylorectomy, only four are reported as permanently cured, and in most of these no date is given as to the duration of the post-operative history. Seventeen patients were not traced at all, and four were not cured by the operations employed. These case histories, says Bréchot, prove "the necessity of resection of the ulcer, and the simultaneous restoration of the gastro-intestinal canal." Let any candid reader compare these records of pylorectomy for benign disease with those of gastro-enterostomy for the same condition. Yet to assure our own sincerity, we are careful to note that Mayo Robson has recently reported the occurrence of gastric carcinoma in four patients among 97 treated by him by gastro-enterostomy at periods of from one to three and a half years after the palliative operation; and Czerny in 1902 found that 3 out of 53 such patients subsequently developed gastric carcinoma. Among the 64 patients of Deaver, traced by Whiting, it is probable, as already mentioned, that 2 died subsequently of carcinoma, at intervals of four and two years respectively after operation. But on the other hand it must not be forgotten that if these patients had been treated primarily by the more dangerous method of gastrectomy, it might have been their fate to have immediately succumbed to the operation—a result immeasurably worse than the remote chance of carcinomatous change several

years subsequent to operation. So that while we admit in the abstract the force of some of the arguments advanced by the advocates of excision, it seems a saner course to limit the more dangerous operation to the more serious condition of acknowledged malignancy; and when there is doubt as to the existence of malignant disease, to perform the more extensive operation only in carefully selected cases. Those gastric ulcers which we think least unsuited for treatment by excision are those encountered at some distance from the pylorus. It has been observed by Moynihan that in such cases gastro-enterostomy is useless or actually harmful; and he very positively expresses (1908) his preference for excision of ulcers "on the lesser curvature toward the cardia." Yet we cannot entirely accept his condemnation of gastro-jejunostomy for ulcers elsewhere than in the pyloric region of the stomach. The patient may not be so markedly benefitted as in the presence of pyloric ulcer; but considerable improvement, if not immediately at least ultimately, we think is to be anticipated.

In stomachs extensively contracted from chronic ulceration Eiselsberg advises the palliative operation of **jejunostomy. Duodenostomy,** above the bile papilla, has been urged by Hartmann as a better operation. His own operation was the fourth on record and his patient, who had extensive burns of the stomach, survived 7 weeks. Bullitt has quite recently adopted this operation in a patient whose stomach was practically obliterated by ulceration. The patient's concondition of slow starvation was arrested, his general health considerably improved, and he was in fair health ten months after the operation.

In regard to the **treatment of hemorrhage,** probably enough has been said in the section on prognosis, where it was pointed out that surgical intervention is most successful in those patients where operation can be done between attacks of hæmatemesis; and that operations done with any idea of locating and ligating the bleeding point, in cases of acute hemorrhage, fail in the immense majority of instances to accomplish the desired result. Yet Dieulafoy urges operation in these very cases "at the opportune moment." In the sudden, profuse and overwhelming bleeding sometimes encountered, and which is generally the first and at times the only symptom of the "exulceratio simplex" known by his name (see page 71), he strongly counsels surgical intervention on the first recurrence of the

bleeding. The first patient whom he saw with this variety of hemorrhage died from recurrence of the profuse hæmatemesis shortly after coming under observation. At the autopsy the seat of the hemorrhage was found in a small arteriole just beneath the muscularis mucosæ, which had been perforated by an "exulceratio simplex." In his second patient he correctly diagnosed the cause of the hemorrhage, and on its recurrence the next morning induced Cazin to operate in the hope of finding and ligating the bleeding point. The stomach was opened and by everting its mucous lining through the incision like a glove on the hand, and by minutely searching among the mucous folds and rugæ, a suspicious looking area was detected. The manipulation and sponging of the area started the hemorrhage afresh, and the arteriole was then ligated, the patient making a good recovery. Robson and Moynihan (*loc. cit.*, p. 177) have recorded two similar cases in which several bleeding points were successfully ligated. We should feel extremely loath to undertake an operation in cases such as these, where the chance of discovering the seat of the hemorrhage is so exceptionally slight, and where medical treatment offers a probability of cure in a fair proportion of cases.

The alarming mortality which attends operations undertaken for the relief of acute hemorrhage may be seen from the following figures, quoted from Lieblein and Hilgenreiner: Hartmann reported a mortality of 63 per cent.; Savariaud, 66 per cent.; Robson (42 cases), 64 per cent.; Quénu, 45 per cent.; Kaupe, 40 per cent. (probably mostly chronic recurrent bleeding). Munro (1904) out of a series of eight patients operated on for acute hemorrhage saved only one. Moynihan's mortality among 27 operations was nearly 26 per cent. Tuffier says that with medical treatment the mortality from acute gastric hemorrhage is only 1.7 per cent., so that even if some cases included under medical treatment were so mild as never to have been considered surgical, and even if we accept the highest mortality under medical treatment, that of 11 per cent., given by Müller, yet the difference in the mortality between medical and surgical treatment is too great for surgical treatment to be preferred in patients with acute hemorrhage save in the most exceptional cases.

Nor in recurrent hemorrhage, when the operation is done in the

interval, should the surgeon seek to ligate or excise the offending ulcer. Gastro-enterostomy is sufficient. Terrier, Kocher, Mikulicz, Mayo Robson, Mayo, Moynihan, Hartmann, v. Eiselsberg, Tuffier, the Boston surgeons, indeed all the operators whose opinions on gastric surgery carry most weight are unanimous in the verdict that gastro-enterostomy is sufficient.

The **treatment of perforation** of a gastric ulcer, is unquestionably operative. Without operation death will be the natural consequence in 99 per cent. of cases. With operation from fifty to sixty per cent. of patients are being saved, and with prompt operation the recovery rate is much greater, some series of statistics showing a mortality as low as ten per cent. Suture of a gastric perforation was first done by Mikulicz in 1889, but without success. The first instance of recovery after suture of a gastric perforation was recorded in 1892 by Kriege. Finney in 1900 collected statistics of 268 gastric perforations treated by operation, the mortality being 48 per cent. F. Brunner, in 1903, collected 387 operations with 186 deaths, a mortality of 48 per cent. English in 1903 analyzed 42 operations for gastric perforation done at St. George's Hospital; of these 20 died, a mortality of 48 per cent. Gross and Gross, whose monograph (1904) on the subject forms the most complete as well as the most recent study of gastric perforation, collected from various sources the reports of 369 operations; among these there were 187 deaths, a mortality of 50.67 per cent. Paterson in 1906 collected 112 consecutive operations for this condition from two London Hospitals, with 58 deaths, a mortality of nearly 52 per cent. He states that during 1904, no less than 58 operations for perforation of gastric ulcers were done in London Hospitals, with 28 deaths, or 48 per cent. mortality. Thus it is evident that in the usual run of cases it is at present impossible to save more than half. If all were operated on at the most opportune time, that is, within a few hours of perforation, the results would be much better, as may be seen in the accompanying table, taken from the monograph of Gross and Gross and from that of Brunner, already alluded to. In 237 instances noted by Gross and Gross the time between perforation and operation was recorded; and the results, as well as Brunner's figures, may be thus presented:

Duration of Perforation.	Mortality Per Cent. Gross & Gross.	Brunner.
Less than 12 hours	25.00	25.00
Less than 24 hours	52.72	46.00
Less than 48 hours	56.06	58.00
More than 48 hours	73.91	80.00

If the results of individual operators are examined, it will be seen also that the personal equation has something to do with the results. Thus a surgeon who has seen a number of these patients will not only make his diagnosis more quickly, and will hence operate sooner, but the operation itself will probably be performed with greater skill and despatch than will one done by the occasional operator. The same will be true of a series of operations done in a well-equipped hospital, by various members of the same staff; the following figures accordingly are not without their interest:

RESULTS OF OPERATIONS FOR GASTRIC PERFORATION.

Operator.	Cases.	Rec.	Died.	Mortality Per Cent.
Anderson (Lancet, 1904, ii, 585)	7	4	3	42.8
Bonheim (Deutsch. Zeit. f. Chir., 1904, lxxv, 389)	10	8	2	20.0
Caird (Scottish Med. & Surg. Jour., 1906, ii, 215)	25	16	9	36.0
Deaver (Records of German Hospital, to June 1, 1908)	6	6	0	0.0*
Eiselsberg (Deutsch. med. Woch., 1906, xxxii, 2017)	12	5	7	58.33
Gibbon (Trans. Phila. Acad. Surg., 1904, vi, 139; Annals of Surg., 1905, i, 289)	5	2	3	60.0
Khautz (Arch. f. klin. Chir. 1908, lxxxv, 700)	11	3	8	72.72
Jaffe (Berl. klin. Woch., 1908, vlv, 346)	4	3	1	25.0
Kirk (Med. Press & Circ., 1905, i, 321)	10	9	1	10.0
Kümmel (cited by Eiselsberg: Deutsch. med. Woch., 1906, xxxii, 2017)	14	5	9	64.27
Littlewood (cited by Mayo Robson, Keen's Surgery, Phila., 1908, Vol. III, p. 866)	31	17	14	45.1
Mitchell (N. Y. Med. Jour., 1905, ii, 417)	13	6	7	53.8
Peck (N. Y. Med. Record, 1907, ii 930)	7	5	2	28.57
Rehn (cited by Noetzel: Beitr. z. klin. Chir., 1907, li, 247)	16	9	7	43.75
Smith (Lancet, 1906; cited by Eiselsberg: Deutsch. med. Woch., 1906, xxxii, 2017)	11	5	6	54.54
Sonnenburg (cited by Federmann: Deutsch Zeit. f. Chir., 1907, lxxxvii, 443)	11	4	7	63.63
Stewart (Trans. Phila. Acad. Surg., 1907, ix, 176)	7	5	2	28.57
White (Brit. Med. Jour., 1904, i, 421)	5	3	2	40.0

* One patient was operated on by A. D. Whiting.

Gross and Gross also analyzed the results in the series of cases collected by them, so as to include operations done within five hours after perforation. Thus they found that of those patients operated on

Within	the	first	five	hours	.....	31.03	per	cent.	died.
"	"	second	"	"	.....	16.25	"	"	"
"	"	third	"	"	.....	42.85	"	"	"
"	"	fourth	"	"	.....	54.00	"	"	"
"	"	fifth	"	"	.....	57.14	"	"	"

This seems to show that operations undertaken within the first five hours are less successful than those done during the second period of five hours; but we think that notwithstanding these figures no surgeon should hesitate to open the abdomen at the earliest possible moment after perforation has occurred. To wait for the shock to pass is usually to await the developement of an irremediable peritonitis; indeed some patients are so profoundly shocked that they do not survive long enough for peritoneal reaction to occur. The apparent contradiction between clinical experience and the figures obtained on analysis could probably in this instance as in others be satisfactorily explained if the cases had been reported in greater detail; when it probably would have been found that the majority of those patients operated on within the first five hours after perforation, suffered from severer lesions than did the others. Shock in these patients, as has already been pointed out, is in large measure due to the presence of air in the peritoneal cavity; several surgeons, moreover, have noted that opening of the peritoneum and allowing the escape of the gas, has materially lessened the shock. So that a reasonable hope of immediately lessening the shock by prompt operation may be entertained. Thus Mitchell says that in one of his patients the pulse was 140 until the peritoneum was opened and the gas allowed to escape, when it fell at once to 96 and became fairly strong and regular. In a second case the escape of gas on opening the peritoneum was accompanied by a fall of the pulse rate from 108 to 88, while the strength of the pulse was distinctly improved. On the other hand, there was very little gaseous distention in another case, and in this patient opening the peritoneum had no appreciable effect on the pulse. Other surgeons

have even suggested aspiration of the intraperitoneal gas as an euthanasial measure, in cases not admitting of operation.

Bearing on this subject the observations of F. Brunner (*loc. cit.*, S. 190) are of interest. He constructed curves to represent graphically the prognosis after operation in cases of gastric perforation. According to this method he finds that the curve of mortality gradually approaches that of recovery up to the eleventh hour after perforation, when it crosses the curve of recovery, and thereafter exceeds it. The curve of recovery before the eleventh hour is parallel with the curve of abdominal rigidity; while the curve of mortality after the eleventh hour is parallel to the curve of abdominal distention. In other words, at the eleventh hour, the chances of recovery are about 50 per cent., being greater before, and growing progressively less after the fateful hour has been passed. The prognosis also is good so long as the abdomen is rigid; but when absorption of peritonitic toxines has caused abdominal distention, the prognosis becomes progressively worse the longer the time that has elapsed since the subsidence of rigidity. All these observations render the importance of prompt operation so much the more apparent.

Most gastric perforations are on the anterior wall of the stomach and are fairly accessible. *Excision* of the ulcer is an unnecessary waste of time; by this procedure, moreover, the surgeon not only leaves himself a larger opening to close, but may also add the complication of hemorrhage to that of perforation, since some good sized vessels may be unwittingly divided. Sero-serous *suture* of the perforation, without even attempting to freshen its edges, is quite sufficient.

But in certain instances it is impossible to close the opening securely by suture, and in some rare cases the perforation will be so situated, or its edges will be so friable that sutures of any kind, even insecure sutures, cannot be inserted. Under such circumstances the surgeon should endeavour to close the perforation by suturing a tag of the great omentum over it, a method which appears to have been first employed in 1897 by Braun. Or the gastro-hepatic omentum may be anchored down to the perforation if more

convenient. In cases where such devices fail, the surgeon should not despair of curing his patient, but should pack off the perforated area with gauze pads, as is done in similar circumstances in other regions of the abdomen. This is a much safer plan than attempting to suture the perforation to the abdominal wall; indeed were figures alone to be our guide, gauze packs should be preferred even to suture of the perforation. F. Brunner (*loc. cit.*, S. 170) collected 15 cases of perforation of the stomach treated by packing without suture. Of these no less than 12 recovered; whereas suture of the perforation to the abdominal wall is nearly always followed by death. To these cases of gastric perforation treated by packing, recorded by Brunner, may be added Wood's patient who also recovered, thus giving 16 recoveries and only 3 deaths for this method of treatment, a mortality of only 18.75 per cent. The resulting gastric fistula has closed spontaneously almost without exception.

Villard and Pinatelle (*loc. cit.*, p. 856) strongly commend packing for ulcers which have perforated among adhesions close to the lesser curvature. After the packs have been placed the greater curvature of the stomach may be sutured to the abdominal wall if there is doubt as to the efficiency of the packs. These authors have collected 9 cases of this character, treated by packing without suture: all three patients in whom the perforation was drained by a tube into the stomach, packed around with gauze, recovered from the operation; while of the remaining six patients in whom gauze packs alone were used, four recovered and two died. The two fatal cases were in patients operated on respectively 37 and 60 hours after perforation had occurred; the first survived the operation by six and the second by ten days, showing that they possessed an unusually good chance of ultimate recovery.

The abdomen should almost invariably be *drained*. The surgeon should studiously avoid the example of Young who, because he thought it impossible to drain well, did not drain at all. The unfortunate patient did well for four weeks in spite of the fact that he had two perforations in his stomach; but finally succumbed in the fifth week to exhaustion due to a large subphrenic abscess.

Should a second perforation be looked for? Undoubtedly it should; but if not readily found further time should not be wasted in a search which will prove futile in four out of five cases at the least, especially since the time so consumed may be more profitably spent, we believe, in the performance of gastro-jejunostomy, in selected cases.

Gastro-enterostomy as a primary operation in a patient with gastric perforation appears to have been first employed by Braun in 1897 when he unexpectedly found a perforation in a patient upon whom he was preparing to do a gastro-enterostomy for pyloric stenosis. Our own opinion is decidedly in favour of gastro-enterostomy. It is not likely that in cases of perforation it will be found expedient to combine a pyloroplasty with excision of the ulcer; and gastro-jejunostomy, which is the form of anastomosis to be preferred, requires so little additional time for its performance in the hands of those who are habituated to abdominal surgery, that the fact that it prolongs the operation cannot justly be urged as an objection. The reason for performing gastro-jejunostomy as a primary operation, is two-fold: first to promote healing of the perforated area, and second to prevent recurrence of symptoms or a subsequent perforation. Yet Villard and Pinatelle think gastro-enterostomy a useless complication, and English is opposed to it. The last-named author traced 17 out of 24 patients who recovered after suture of a gastric perforation, no gastro-enterostomy having been done in any case. Of these 17 patients, 13 had no further gastric symptoms (2 of these having married and borne children), and 4 were dyspeptic, presenting symptoms not of acute ulcer, but of a cicatrix and adhesions. Yet the other side of the question may be supported by even more convincing facts: Paterson states that among the cases of gastric perforation which he collected, no less than 13 deaths out of a total of 58 could almost certainly have been prevented if a primary gastro-enterostomy had been done; so that were these patients transferred to the recovery column, the death rate would have been reduced from nearly 52 per cent. to 40 per cent. Indeed Paterson goes further than we should be inclined to do, and claims that even purulent peritonitis is no contra-

indication to gastro-enterostomy. Bonheim succeeded in tracing only two patients. They had not been treated by a primary gastro-enterostomy; one had a subphrenic abscess, and finally recovered after another operation; while the other suffered from a recurrence of symptoms of gastric ulceration. In not a few instances patients who have been operated on for gastric perforation and have not had a gastro-enterostomy done primarily, have been forced to submit to this operation as a secondary procedure to secure relief from their gastric symptoms. Allingham and Thorpe had to do gastro-enterostomy one month later to accelerate their patient's convalescence; Scudder resorted to it five weeks after, and Gibbon eighteen months after suture of the gastric perforation. Mayo and Moynihan have had a similar experience.

It has been possible to collect from the recent literature only 22 instances in which gastro-enterostomy was employed as a primary operation. Of these patients, 17 recovered (Anderson, 1; Caird, 1; Clayton-Green, 1; Jones, 2; Lund, 3; Lusk, 1; Mayo, 3; Moynihan, 5) and only 5 died (Caird, 1; D. F. Jones, 1; Mayo, 2; Moynihan, 1), the death in Jones's patient not occurring until the third week, and being attributed to perforation by the Murphy button with which the gastro-intestinal anastomosis was made. To these cases collected from the literature, may be added five cases operated on at the German Hospital by Deaver, gastro-jejunostomy being employed as a primary operation in every case, and all of the patients recovering. It is thus, we think, evident, that in any case where it is not specifically and positively contra-indicated, gastro-jejunostomy should be employed as a primary operation in patients with gastric perforation. Especially important is a primary gastro-jejunostomy if the perforation is close to the pylorus, for it will then be very likely to cause obstruction when cicatrization has been completed. Perforations near the lesser curvature, as noted by Moynihan, do not so urgently call for gastro-enterostomy.

Exploratory Laparotomy. Operations undertaken in patients suspected of having suffered perforation of a gastric ulcer, must in the nature of things at times be merely explorations. A

positive diagnosis is not always possible, and it is usually more to the patient's interest for the surgeon with proper technique at his disposal, to explore the abdomen, than for an operation to be postponed until the advent of unmistakable peritonitis renders the diagnosis certain. Gross and Gross, in their extensive review of the literature found records of only two patients who died after being subjected to a *laparotomie blanche*, as it has been called—that is to say a laparotomy in which no lesions were found to account for the symptoms. Nor could these two solitary deaths be attributed to the exploratory operation, since death in one was due to persistent hæmatemesis, for which no cause could be found, and in the other was caused by the rupture of an aortic aneurism. *Laparotomie blanche* has been reported by Kirk (3 cases), by English (3 cases), and by Körte (2 cases). English also mentions 4 other patients in whom operations were undertaken for gastric perforation, but in whom the symptoms were found to have another cause.

Œsophageal perforations into the peritoneal cavity have been recorded by Körte, as well as by Mesnard and Feroualle. Both patients died.

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CHAPTER V.

BENIGN DISEASES OF THE STOMACH AND DUODENUM (Continued).

PYLORIC OBSTRUCTION.

Under the general heading of pyloric obstruction it is convenient to group three distinct affections. These are **Infantile Pyloric Stenosis, Pylorospasm,** and **Gastric Dilatation.** Although pylorospasm may possibly be considered merely a symptom, and gastric dilatation a complication or a consequence of gastric ulcer, yet each of them seems of sufficient importance to render its inclusion within the present section not only logically but also clinically advisable.

Infantile Stenosis of the Pylorus.

Congenital Hypertrophy of the Pylorus, or Hyperemesis Lactantium, as it has been variously called, is not yet a distinct pathological entity. As early as 1788, Beardsley of New Haven is said, on the authority of Osler, to have recognized this disease clinically, and to have described his findings at autopsy, under the name of scirrhus of the pylorus. Surgical treatment was first proposed in 1896 by Schwyzer who suggested Loreta's operation; and was first employed in 1897 by Stern who operated by gastro-enterostomy. The first successful operation, also by gastro-enterostomy, was performed in 1898 by Löbker. Further references to the literature may be found in the articles of Neurath, Trantenroth, Cautley and Dent, and Wachenheim.

Because surgeons are not yet in accord as to the pathological changes producing the symptomatology, some authors, notably Meinhard Schmidt, have preferred to retain the original sympto-

matic name Hyperemesis Lactantium. But the trend of modern opinion is toward the adoption of the term Infantile Stenosis, which while not asserting that the condition is a congenital deformity, as some have maintained, nor committing the writer to any clearly defined pathology, nevertheless expresses with sufficient accuracy the changes usually found at operation or necropsy.

Ætiology.—Three theories have been recognized as to the causation of the symptoms about to be described. These may be briefly denominated the congenital abnormality theory, the hypertrophy theory, and the theory of simple spasm. The first asserts that the pyloric stenosis is a congenital abnormality quite as truly as hare-lip, webbed fingers, or imperforation of the anus. Cautley and Dent state that the pyloric thickening is primary, and due simply to a redundance of tissue, placed there by nature as the result of over-exertion in forming the ordinary sphincter. In support of this theory, Neurath asserted that a family predisposition might exist, quoting Henschel who observed three, and Ashby who observed four cases in the same family. Moreover, in one of Ashby's cases there was also atresia ani, a fact which Neurath thinks lends support to the congenital abnormality theory, not to that of spasm nor to that of hypertrophy. Actual atresia of the pylorus or duodenum has in a few instances been found at autopsy (Cleemann, Eastes, Goodhart, Habheggar, Lesshaft, etc.). Should it by any possibility be recognized during life, it would of course be susceptible of operative relief, even if with very small chance of success. Maylard has called attention to congenital narrowness of the pylorus, not caused by hyperplasia of the pyloric sphincter, as a cause of indigestion in young adults; Mayo Robson has also seen it; and it is of course possible that some cases of hyperemesis lactantium may be due to a similar condition. But that the symptoms of this malady are very rarely manifested before the baby is a week old at least, and that in several instances children no longer infants have developed the disease (Sonnenburg's patient was six years of age), are facts which militate strongly against the assumption that the affection is due to any deformity existing before birth. At almost every autopsy and operation at

which the pylorus in these patients has been brought to view, the actual condition has been found to be one of increase in the muscular tissue, particularly the circular muscle fibres surrounding the pyloric opening of the stomach. And what lends further support to the theory that it is an hypertrophic, not a neoplastic, overgrowth, is the fact that on the gastric side the thickening is not sharply limited, but extends for some distance into the pyloric portion of the stomach, as an hypertrophic overgrowth might be expected to do, since the pyloric antrum would naturally be involved in such change; whereas on the duodenal side the thickening ceases suddenly, and within a very short space after the pylorus is passed the duodenum has been found to present its normal characteristics.

To induce this hypertrophy alleged to be the pathological change, it may be assumed that there is or that there has been a small erosion or fissure in the pyloric region of the stomach, and that there has also been hyperacidity of the gastric juice. That these factors, so well known as causes of pylorospasm in the adult, should in the infant be provocative of like change, appears in no way unreasonable; and if it be objected that sufficient time does not elapse between birth and the occurrence of the hypertrophy for it to be explained on these grounds, it may with perfect justice be replied that infantile tissues cannot always be judged by standards derived from adult life. John Thomson, the well known pædiatrist, has supported the theory of hypertrophy due to incoördination of the muscle during fœtal life, and Jedlicka also maintains that prolonged spasm may induce hypertrophy. Meinhard Schmidt compares the condition to that of vaginismus, tenesmus ani, and blepharospasm, which are frequently caused by fissure or ulcer. Yet Rolleston reminds us that no hypertrophy of the pylorus is found in Reichmann's disease, gastro-succorhœa, which is usually accompanied by pylorospasm. But as has been said before, it is not always safe to argue from adult to infantile conditions. Pfaundler, while not denying the presence in some of these patients of increase of muscular tissue, considers the condition in most instances merely one of spasticity. But as Cautley and Dent point out, the cut sphincter does

not retract, which it certainly would do, were the condition merely one of spastictity. Heubner, from a study of 41 cases encountered among 10,000 children, concludes that the affection is due to pylorospasm causing hypertrophy. And Pfaundler, in his latest utterance, recognizes the existence of two forms—hypertrophic and spasmodic—the latter being intermittent in character. Our own tendency is to hold that the unquestionable increase in muscular tissue is in the nature of an hypertrophy, and is brought about by persistent spasm due to irritation from one cause or another.

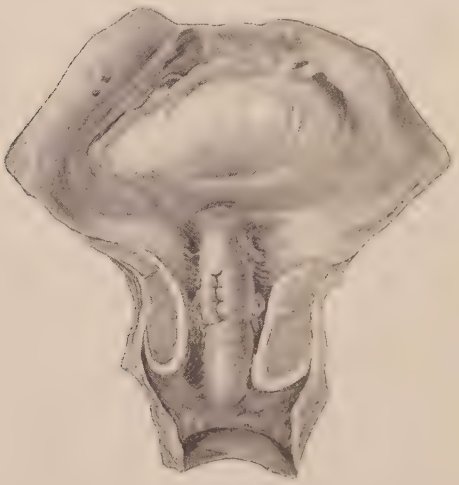

Fig. 19.—Infantile Stenosis of the Pylorus. Natural Size.

Note the thickened sphincter and the fold of mucous membrane occluding the orifice.

The redundance of mucous membrane, to be presently alluded to, may act itself so as to provoke spasm, much as a polypus does in the same and in similar situations. It should, perhaps, be noted that Wernstedt has tried to explain the presence of this mucous fold by studies in comparative anatomy. Irritating diet in some patients, notably in Gardner's, has been almost certainly the cause of spasm; while the existence of a small fissure or erosion may be assumed unless the contrary can be proved. Hyperacidity, at first very probably a consequence of the stenosis, may soon become a cause of its continuance.

It is to be hoped that further study, both clinical and microscopical, will elucidate these questions, and place the pathology of this serious condition on a firm basis. Until then we must be content to theorize as to the causes, and proceed as best we may, empirically, to adopt uncertain treatment for fairly characteristic symptoms.

The usual appearance of the parts involved is very well shown in Figure 19, copied from Cautley and Dent's article. At first glance the resemblance to an enlarged prostate with the bladder attached, is quite striking; and this becomes greater when on more careful examination we see a fold of mucous membrane which corresponds very closely in appearance to the uvula vesicæ. This mucous fold is a characteristic feature of infantile pyloric stenosis, and often renders nearly complete the obliteration of the passage from the stomach to the duodenum, even when the mere muscular mass would with ease permit the passage of a probe through the pylorus. Meinhard Schmidt estimates the calibre of the normal pylorus at birth as admitting a No. 19 French sound, and as increasing one number of the French scale (or one-third of a millimetre in diameter) for each month of life; so that a diameter of nine millimetres, equal to No. 27 of the French scale, would be normal for a child of eight or nine months of age, and at twelve months of age the normal pylorus should admit a No. 32 F. According to Fisk, Still has stated that at six months of age the normal pyloric wall is about 2.5 mm. thick; while in hypertrophic stenosis it has been found to vary from 3.5 to 5.7 mm. in thickness.

In only a few instances have there been any microscopical evidences, even slight, of acute inflammation; so that with our present knowledge we are limited to the theories already mentioned of neoplastic and hypertrophic overgrowth, the latter seeming the more reasonable of the two.

Symptoms.—The symptoms of this affection do not differ materially from those of the same condition in adults. The chief subjective signs are vomiting and constipation, and the chief objective signs are a pyloric tumor and visible gastric peristalsis. The vomiting usually does not begin until the baby is about a week or ten days old, though in rare instances it has been noted from birth, or has not appeared for a month or more. In the earliest stages liquids may be rejected almost as soon as they are swallowed. The vomiting is nearly invariably cumulative, when the disease has lasted more than a few weeks; that is to say, three or

four feedings will be retained, and then after the last feeding the whole of the gastric contents will be rejected at once. Hyperacidity is usually present. Bile is conspicuous by its absence from the vomitus. The lack of absorption is accountable for the constant hunger, the persistent constipation, and the progressive emaciation. These babies should be weighed at regular intervals. There is no other method which so surely shows the loss of flesh. As emaciation proceeds and the vomiting becomes more marked, as it usually does, there is as a rule very little difficulty in detecting a pyloric tumor; indeed this is frequently visible to the most casual glance, projecting from the sunken and withered belly in a characteristic manner. Close observation will now usually detect peristaltic waves in the stomach, commencing in the left hypochondriac region, passing across the epigastrium, and culminating in the pyloric tumor which sometimes may be felt to become denser on contraction. At rare intervals a peristaltic wave may pass beyond the stenosed pylorus, and diffuse itself through the small intestines, but as a rule the visible contraction ceases at the pylorus. When this stage is well advanced, gastric dilatation commences, and may become excessive. It is recognized by the usual signs.

Tetany, evidently of gastric origin, was a marked symptom in a case operated on unsuccessfully by Munro.

Prognosis.—It is difficult to reach definite conclusions as to the prognosis of a disease about the pathology of which so little is known. If we follow some authors in placing every case of rebellious infantile vomiting in this category, the prognosis will be fairly good, since the largest proportion of such babies soon recover when their diet is regulated in quality and in quantity. If, on the other hand, we claim that all infants who recover without operation never had pyloric stenosis, or assert with Cautley and Dent that unless operated on all these patients die before they are four months of age—then, under these circumstances, we repeat, the prognosis must be considered grave. And on our fundamental belief as to the gravity of the prognosis our ideas as to surgical treatment must be based. It is probably safe to assert with Melt-

zer that if these infants survive without operation more than four months their grade of stenosis must have been slight.

Treatment.—It is needless to say that medical treatment should first be extensively tried; and it is our belief that in the immense majority of cases medical treatment promptly instituted and energetically applied will be successful in curing the patient. If the views as to the pathology of the affection set forth in these pages be correct, that the thickening is not neoplastic, but is developed as the result of irritation of some kind or another, then there is every reason to think that medical treatment will in most cases be able to prevent the hypertrophic overgrowth of muscle tissue; and in a few cases to arrest it and perhaps to cause its disappearance if such treatment had not been instituted as promptly as was desirable. The average surgeon is too apt to overlook the fact that cures have resulted, even in advanced cases, under judicious medical treatment. Against the figures of Neurath, who collected 41 cases of pyloric stenosis in infants less than twelve months old, all of whom died under medical treatment, must be set occasional case reports like that of Gardner and those of Bloch, in the latter of which there are recorded twelve cases of infantile pyloric stenosis, 8 patients recovering without operation, 2 dying with the performance of Loreta's operation, and 2 being moribund when admitted and dying soon after, without operation.

Where medical treatment fails, or where it has not been instituted until too late to be of any value, then surgery is available; and the one practical point to be learned from a study of statistics already published, is that the earlier an operation is done, when once it has been determined upon, the greater is the chance of success. Progressive loss of weight is in our opinion the most imperative indication for operation. Unless weight is being lost it is almost certain that a sufficient amount of food is being absorbed to sustain life, no matter how constant and copious the vomiting may seem to be. According to Fisk's figures, the average age at which successful gastro-jejunostomies have been done is 6.7 weeks; while the average age for the fatal gastro-jejunostomies is 8 weeks.

When surgical intervention has been decided upon, it then becomes necessary to select some form of operation; and in doing this we should be guided not only by the change in the stomach, but also by the tender age of the patient. The operations employed have been **pylorodiosis** (Nicoll, M. Schmidt, Stiles, Burghard, Grisson, Mackay, Grunneberg, Bloch), **pyloroplasty** (Braun, Dent, Gillavry, Granborn, Campbell, Guthrie, Morison), and **gastro-jejunostomy** (Stern, Meyer, Löbker, Fritsche, Abel, Kehr, Stiles, Mikulicz, Nicoll, Monnier, Trantenroth, Jordan, Braun, Schotten, Mackay, Jakh, Bull, Pinner, Munro, Bottomley, Giles, Elting, Scudder, Ibrahim, Rogers, Stone, Roberston, Murphy, Abt, Barling, Kimball and Hartley, Bloch, Cheney, Bunts). **Pylorectomy** has been employed only once, by Stiles, with fatal result. Sturmdorf employed *gastro-pyloro-duodenostomy* unsuccessfully in one case.

Simple pylorodiosis was performed by Schmidt with steel sounds passed through the pylorus by means of an incision in the stomach. In this manner any degree of dilatation, corresponding to the scale for infants already given (page 137), may be obtained. It is an operation which may be quickly performed, requires very little exposure of the viscera, and is therefore theoretically safe. But in not a few instances the pylorus has split instead of stretching, and death has resulted from shock or peritonitis. Dufour and Fredet have collected 36 operations by this method, with 9 deaths, a mortality of 41.66 per cent.; and since one of the patients who recovered required gastro-enterostomy three weeks later, the figures are not really so good as they seem. Pyloroplasty has its advocates and its adversaries for this condition, as for others. It is asserted that the thickness of the pylorus renders the operation difficult and dangerous. It is maintained, on the other hand, that these objections are merely theoretical, and that actual experience with the operation proves it easy of execution, safe, and thoroughly efficient. As performed by Nicoll, in conjunction with divulsion, it certainly seems to bear out these statements. Nicoll, whose record, we believe, has not been surpassed, has reported sixteen operations of various kinds for infantile pyloric stenosis, with only

four deaths, a mortality of 25 per cent. His first patient, alive and well seven years after the operation, was operated on in 1899 by simple divulsion; and the six latest patients, of whom only one died (from shock) were operated on at ages varying from three weeks to ten months by the following technique: An incision is made in Λ or V-shape down to the mucosa of the pylorus, which is not opened. The pylorus is then forcibly divulsed by forceps introduced through a separate incision in the anterior wall of the stomach. The incision in the pyloric wall is then closed thus, Λ or Y. Clamps are used on the stomach and duodenum to prevent extravasation of their contents. No recurrence was noted. Fisk has collected in all 11 operations by pyloroplasty, with 5 deaths, a mortality of 45.46 per cent. But as two of these deaths did not occur until five weeks and ten weeks respectively after the operation, and as they were in no wise caused by the operation, Fisk thinks it fair to count them as recoveries, which would give 8 recoveries and only 3 deaths, or a mortality of 27.28 per cent. But of the 22 pyloroplasties collected by Dufour and Fredet 9 ended fatally, a mortality of 40.9 per cent. Gastro-jejunostomy, the most radical operation available, has been employed, according to Bunts, in 69 cases with 37 deaths, a mortality of 53.60 per cent. In favour of gastro-jejunostomy the most that can be said is that if it does not kill it will cure. No recurrences have been noted in patients who have survived. But it does seem to us that not only is it too dangerous a remedy to be indiscriminately applied to infants, but that it is inherently wrong to start children off on what it is hoped may be a long life, with their gastro-intestinal tract so distorted as it is after even the most skillfully executed gastro-jejunostomy. It appears to us that the surgeon who has occasion to operate on patients with this disease should aim to do some form of pyloroplasty; and that only when such a procedure is found on opening the abdomen to be impracticable, should he resort to gastro-jejunostomy. When employed, the posterior "no-loop" operation should be adopted, the anastomosis being accomplished by suture without mechanical device.

SUMMARY OF OPERATIONS FOR INFANTILE STENOSIS OF THE PYLORUS.

(*After Dufour and Fredet.*)

Operation.	No. of Cases.	Rec.	Died.	Mortality Per Cent.
Exploratory laparotomy	2	0	2	100.00
Jejunostomy	1	0	1	100.00
Pylorectomy	1	0	1	100.00
Pylorodiosis	36	21	15	41.66
Pyloroplasty	22	13	9	40.9
Nicoll's operation	13	11	2	15.38
Gastro-jejunostomy (Bunts)	69	32	37	53.60
Not named	8	2	6	75.0
	152	79	73	48.02

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Pylorospasm.

This is an intermittent or constant contraction of the pyloric sphincter, attended by more or less evident symptoms. Some physicians recognize both a primary and a secondary form; thus Hemmeter says: "While the existence of a secondary cramp of the pylorus is generally recognized, strange to say the existence of a primary cramp of the pylorus, caused by an independent motor neurosis, restricted to the pylorus alone, is still generally denied. If one grants, however, that the insufficiency of the pylorus may appear also as a genuine motor neurosis, due to a decrease of the irritability of the motor nerve apparatus of the pylorus, there is no reason to deny entirely the occurrence of a primary cramp of the pylorus, which is due to an abnormally increased irritability of the motor nerves, even though this be rare." No one can dispute the fact that surgery can only legitimately concern itself with the secondary form of pylorospasm—that form caused by some definite anatomical change. But as the surgeon must not be content to take his diagnosis ready made from the physician, and as it seems to us that Hemmeter's premises are open to dispute, no matter how logical his conclusions may be, it appears not improper to question in this place the existence of a primary, purely functional, pylorospasm, which can be productive of significant symptoms. We hope not to be charged with "beating the air," when we admit on the one hand, the abstract possibility of the existence of a primary spasm of the pylorus, and when we deny, on the other, the concrete presence of any form of pylorospasm not produced by some anatomical change. It is no more unreasonable to deny the existence of primary pylorospasm than it is to deny that of idiopathic peritonitis; and to assert that every case of pylorospasm for which no gross pathological change can be found must be purely functional in origin, appears to us quite as illogical as it would be with our present knowledge of the path-

ology of peritonitis to class all obscure abdominal inflammations as idiopathic peritonitis, as was formerly done. It is our firm belief that the cases of so-called primary pylorospasm are due to the same causes as those operative in easily recognized cases of secondary cramp of the pylorus, though in the former class of cases the causes are no doubt less in degree, and hence are more readily relieved by medical means. We may even go further, and state that we have never seen a case of purely functional pylorospasm, and that none of our medical brethren have been able to furnish even one patient in whom they were confident that operation or necropsy would reveal no anatomical cause for the spasm. When we know what very alarming hemorrhage may come from a minute erosion in the stomach scarcely to be detected by the most painstaking post-mortem investigation, surely it is senseless to deny that a somewhat similar lesion, not perforating a blood vessel, may also be present in patients with pylorospasm, and may heal under medical treatment and leave no trace of its existence. What was said in support of the theory of hypertrophy from spasm, when speaking of the causes of infantile stenosis of the pylorus, should be borne in mind in connection with pylorospasm in adults; and the similarity pointed out by Meinhard Schmidt between the former condition and blepharospasm, vaginismus, tenesmus ani, etc., should not be forgotten.

Pylorospasm is really only a symptom of some other malady, or of one of a number of diseases met with in the upper abdomen. It will be noted that in the definition of pylorospasm already given it was stated to be an *intermittent* or *constant* contraction of the sphincter. It is very rarely a *remittent* contraction: that is to say, the spasm may occur only once or twice in a person's lifetime—it may be a spasm which "comes back at times"; or it may be, and more frequently is, an intermittent contraction—one which "goes away at times"; and in rare instances the spasm may be constant for a period of two or three days or longer, without any intermission. The first form is that which is a frequent accompaniment of gall-stone colic; and may occur in other acute affections of the upper abdomen, being here, as under other circum-

stances, merely a symptom of an organic lesion of the alimentary canal.

In many cases the pain of the cramp is not very great, amounting merely to a lively sense of discomfort in the epigastric region, and being overshadowed by symptoms of "peristaltic unrest of the stomach," so graphically described by Kussmaul ("embarras gastrique" of the French). When the pylorus contracts spasmodically, from whatever source of irritation there may be present, the stomach meets with an insuperable obstacle to its evacuation. Peristaltic unrest ensues, flatulence developes from fermentation and from swallowed air, and finally, when the limit of endurance is reached, the pylorus relaxes and gastric contents pass out into the duodenum, or the patient is relieved of his distress by vomiting, and comparative comfort is restored.

Such a crisis as this may occur, as already remarked, only once or twice in a patient's lifetime; or it may be the habitual sequel to every meal. The symptoms may vary from those of the mildest gastric indigestion, to the most awful and overwhelming pain in the region of the pylorus. The pain attendant on cramp of the gall-bladder; that encountered in patients with vesical tenesmus from enlarged prostate, stone, severe cystitis, or sclerosis of the neck of the bladder; the more frequently seen colic of the intestines—these are all symptoms of disease in the part affected, as is pylorospasm of disease in the upper abdomen.

It is not always possible to determine just what is the underlying disease in cases of pylorospasm. It is probably more often due to an erosion or ulcer of the stomach or pyloric antrum than to any other single affection; but as already remarked, it is a frequent accompaniment of affections of the gall-bladder; and may be the only distinctive symptom in patients with polypus of the stomach. Until further investigation teaches us more, we must be content in the majority of cases to treat the condition empirically.

If the pylorospasm persists, intermittently, over a long period, it is wont to be accompanied by symptoms of Reichmann's disease—excessive secretion of the stomach, gastro-succorrhœa; but whether this disease is a sequel or a cause of pylorospasm physicians are

not agreed; and a further discussion of the subject would be out of place in a work of this kind. Gastric dilatation may also follow; and it would not be improbable that hypertrophy of the pyloric sphincter might be a sequel of long standing pylorospasm in some patients, though we are not aware that such a change has ever been demonstrated. The most intelligible description of these allied conditions, with which we are acquainted, is to be found in VanValzah and Nisbet's "Diseases of the Stomach" (London, 1900), and to it the reader who desires further information on the subject is respectfully referred.

Pylorospasm should first be treated energetically by medical means; and in cases where reasonable persistence along this line fails, surgical intervention must be considered. If the stomach be not enlarged, and its motility remain good, pyloroplasty, or preferably Finney's operation, may be expected to give good results. But in most patients seen by the surgeon gastric dilatation is so pronounced that only gastro-jejunostomy can be expected to cure.

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Gastric Dilatation.

Although the interest of the surgeon in gastric dilatation is usually confined to those forms which are strictly secondary in origin, and which are in the immense majority of cases, if not in all, produced by pyloric obstruction; and although for this reason it has seemed best to discuss the subject under the general heading of obstruction of the pylorus, yet there are certain forms of dilatation of the stomach which have of late years come within the surgical horizon, and yet which are not technically due to obstruction of the pylorus. We refer to acute dilatation of the stomach, and to the form known to physicians as atonic dilatation or gastric myasthenia.

Both of these affections are in their essence medical, inasmuch

as we must believe with our present knowledge that they are usually functional disturbances. But since even in some diseases formerly thought to be functional, surgery has of late years brought about a cure by improving the mechanical power of the organ concerned, and as in these very affections—acute and atonic dilatation of the stomach—operations are occasionally of benefit after purely medical treatment has been proved of no avail, a short discussion of the symptoms encountered and of the surgical treatment which may be called for, is surely a suitable addition to a treatise on the surgery of the upper abdomen.

Acute Dilatation of the Stomach, first brought to the attention of the medical world in 1872 by Hilton Fagge, has been recently discussed in elabourate articles by Neck, by Conner, and by Laffer, who has collected 217 cases. It is, as already remarked, primarily a medical disease. It is met with as a complication in various infectious diseases, such as pneumonia and typhoid fever, but occasionally seems to arise as a primary affection, the patient being suddenly seized with symptoms of obstruction, and there being no preceding disease of any kind. More often, however, and this is what has drawn surgical attention to it, the dilatation developes as a post-operative complication, and in many cases terminates fatally within twenty-four to forty-eight hours. The preceding operation is by no means always an abdominal one. Operations on the extremities, on the kidneys, and on other parts of the body have been followed by acute dilatation of the stomach; a large number of post-operative cases have followed operations on the biliary tract.

Causes.—Various theories have been advanced to explain the condition, and their number shows that no one can be considered wholly sufficient to explain its developement under the different circumstances in which it is encountered. As predisposing causes have been recognized atonic dilatation of the stomach; pyloric obstruction whether associated or not with chronic gastrectasis; overfilling of the stomach with food or drink (lemonade and champagne have in some patients been accused as exciting causes); pre-existing toxæmias (typhoid fever, pneumonia, etc.); and lastly surgical operations. Routier apparently thinks all postoperative

cases are to be attributed to septic intoxication; but it must be acknowledged, if this is true, that in most instances none of the usual signs of sepsis are present. Most patients are between twenty and thirty years of age. Zade adds to the predisposing causes already mentioned, that of abnormal length of the mesentery, or a position of the small bowels in the pelvis, thus pulling on the mesentery. Indeed the theory proposed by Hanau-Albrecht in 1899, that acute gastric dilatation is due to constriction of the duodenum by the superior mesenteric artery, through dragging on the root of the mesentery, has received more support of late years than any other. But most authors think that the dilatation is primary, and that it is merely increased by kinking of the pylorus or by the distended stomach itself pressing on and occluding the duodenum. The observations of Kelling and others, referred to in Chapter II, as to the gastro-duodenal reflex, by which evacuation of the stomach is prevented by distention of the duodenum, have probably a close bearing on this subject; and since in many cases which have come to autopsy there has been found (Neck) some obstruction to the duodenum at its junction with the jejunum, and but rarely has there been found pyloric obstruction, it seems only fair to conclude that the mechanical obstruction thus produced is at least as sufficient an explanation as is the assertion that the dilatation is primary, or due to some lesion of the pneumogastric nerves, as suggested by Carrion and Hallon. Laffer also supports this theory. It is not improbable, we admit, that in those cases of acute gastric dilatation developing after operations on the biliary tract, there may have been produced some reflex disturbances of gastric innervation by way of the splanchnics and the hepatic plexus; yet we are totally unable to see how a similar explanation could by any stretch of the imagination be considered applicable to the cases of those patients who had had operations performed on their lower extremities. It appears to us that it is a much more likely thing that the anæsthetization, and the lifting of the patient on and off the stretcher and the operating table, added to the frequently unusual and strained positions in which patients lie during and after operation, are all factors which would tend

to produce an enteroptosis of the small intestines, or would in some way produce a kink at the duodeno-jejunal flexure, and so would be productive of the state of affairs usually found in connection with acute gastric dilatation. Added to these causes, which might be present in every post-operative case, would be the direct interference with the viscera in abdominal operations of all kinds. Especially would this be the case in operations on the bile passages, where the duodenum and small intestines are constantly pressed by gauze pads out of their normal relations; and in operations for the removal of large ovarian cysts or myomatous uteres, where the small intestines would naturally fall into the emptied pelvis and occupy a position which in that individual patient would be strange and unusual. This theory has been ably supported by P. Müller. Seelig has suggested that the application of a very tight abdominal binder may favour the occurrence of acute gastric dilatation, because although the small intestines may work their way by peristalsis down into the pelvis under such an obstruction, they will be unable to get back again, and as they accumulate in the lower abdomen will render the root of the mesentery taut.

Of the 102 cases analyzed by Conner, 42 (41 per cent.) followed operations in which general anæsthesia was employed (15 operations on gall-bladder, etc.; 17 after other abdominal operations; 10 after operations not involving the abdomen); other cases were observed during or after severe diseases (typhoid fever, pneumonia, etc.); others after injuries; others after indiscretions in diet; six were associated with disease or deformity of the spine, and four appeared to be idiopathic in origin. One patient with typhoid fever, who died from acute dilatation of the stomach, has come under the notice of Dr. Ashhurst at the Episcopal Hospital, in the service of Charles H. Weber.

Pathology.—The stomach is found to fill practically the whole abdomen. Its shape is characteristic, presenting usually a marked V-shaped depression in the lesser curvature, and approximating the form found in gastroptosis, especially that due to deformity from tight lacing, though very much more pronounced. As pointed out in the previous paragraphs, a site of obstruction has most fre-

quently been found in the neighbourhood of the duodeno-jejunal flexure, or else where the superior mesenteric artery crosses the duodenum. Among 120 cases which came to autopsy, Laffer states that there was obstruction of the duodenum by the root of the mesentery in 27. The duodenum as far as the point of constriction is frequently much dilated. There is rarely any obstruction at the pylorus, unless it is manifestly due to a kink produced

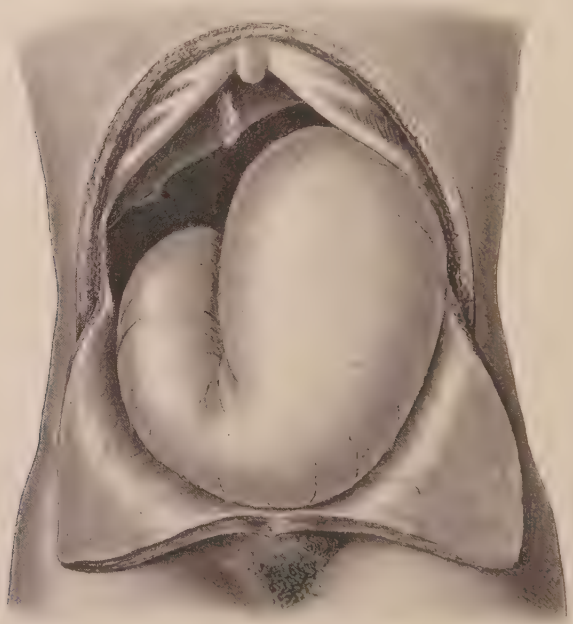

Fig. 20.—Campbell Thompson's Case of Acute Dilatation of the Stomach.

by the descent of the stomach. The fluid contents of the stomach are due to hypersecretion, as well as to mere accumulation from obstruction of its outlets. But the presence of the immense quantities of gas, and its rapid re-accumulation after lavage are not so easily explained. The gas is no doubt in large part due to fermentation, and some of it is swallowed, as in the nervous affection known as aërophagia. But to account for the re-accumulation

of gas in so short a space of time, some authors have held that gas was produced by transudation from the blood vessels in the stomach walls. Whether this is in accord with modern physiological views we do not know, but it appears to be a far-fetched explanation. Gas-producing bacteria have been found in the stomach contents, according to some reports.

There is as a rule no peritonitis; and the site of operation, if an abdominal operation had been performed, usually presents no deviations from the normal. Some writers have confused tympanitic distension of the stomach from peritonitis, with acute dilatation of the stomach. In the former condition, which is by no means so rare as acute dilatation, the whole intestinal tract may be much dilated, but the stomach, being the largest hollow organ, is apparently disproportionately dilated; hence the confusion.

Symptoms.—The symptoms of this malady cannot be said to be always very distinct or readily recognized. Usually the onset is sudden in character, and may begin from twelve to twenty-four hours after the operation, although in many instances no symptoms have developed until convalescence was thought to be assured. The patient's first complaint is generally *pain*, referred to the epigastrium, with a sense of distention. *Vomiting* occurs promptly, with comparatively little nausea; and large amounts of dark greenish fluid are gulped up without straining. The vomitus is almost never fæcal, and is seldom very offensive. Bile and blood may be present, but usually the vomited matters are composed chiefly of gastric secretion and mucus, and present a characteristic smell. Vomiting generally persists to the end, whether this be the death or the recovery of the patient.

The *distention* of the abdomen may be readily recognized by the eye, being most prominent to the left of the median line. When the stomach tube is passed there is an abundant escape of odourless gas, with a gushing or a gurgling sound, even at times almost an explosion; and a marked flattening of the abdomen usually follows evacuation of the stomach by this means. But within a very short time after the stomach has been emptied it refills again, with secretion and air, and the patient's distress is as great as

ever. Peristalsis is extremely rare, having been observed only once, by Schultz, according to Robson and Moynihan. Palpation finds the abdominal walls not rigid, as in peritonitis, but merely tense from the tension within. A *splashing sound* is readily obtained from the stomach contents, and is usually too distinct for there to be any doubt that it comes from an air-containing cavity. The distention of the stomach is extreme, the greater curvature always reaching well below the umbilicus, and frequently extending to the pelvis. Percussion detects a *tympanitic note* over the most prominent portion of the distended stomach, and the usual change of level in the *dulness* produced by fluid can be obtained by turning the patient to one side.

Along with these local signs, the *general condition* of the patient is seen to have taken a sudden turn for the worse. There is usually little fever, but the pulse becomes thready and rapid, the eyes sunken and bright, the tongue heavily coated, the breath foul, the mind delirious or comatose, and dissolution appears imminent. In short the evidences of toxæmia are pronounced.

In milder cases of the same nature, the stomach is relieved by lavage or by vomiting; and occasionally a profuse diarrhœa is the first symptom that the obstruction has been overcome. In Roussel's patient there were from 25 to 35 extremely offensive movements daily. It is much better to remove the secretions by lavage, since sometimes fatal absorption from the small intestines will kill a patient in whom the subsidence of the dilatation of the stomach and the evident onward passage of its contents had given rise to hopes of recovery.

Differential Diagnosis.— It is important that the surgeon should not mistake the vomiting caused by acute dilatation of the stomach for that due to the anæsthetic. In the former the symptoms usually do not arise until all nausea from the anæsthetic has subsided; but occasionally when the post-operative nausea is severe and long continued the condition may pass into that of acute gastric dilatation without any pronounced change in symptoms. Peritonitis is frequently thought of when the symptoms of acute gastric dilatation commence. The period of onset of both

frequently is similar, but the signs are not the same. Not only is the pain of a different character, being rather burning than sharp; but the physical evidences of a large amount of fluid, and above all the presence of the succussion splash, will at once show that peritonitis alone is not the condition present. Furthermore, the evacuation of the gas and other stomach contents with the subsidence of the abdominal distention, which follow the passage of the stomach tube, confirm the diagnosis, and usually, for a time at least, produce a remission of symptoms. Neither peritonitis nor intestinal obstruction will be so affected. Finally, the nature of the preceding operation, or the previous course of the disease when no operation has been performed, may be sufficient to exclude both peritonitis and intestinal obstruction. Thus operations on the kidneys or the extremities, and even many abdominal operations, such as those for the radical cure of hernia, could under no normal circumstances be productive of peritonitis.

Prognosis.—Among the 217 cases of this affection collected by Laffer, 135 patients died, some within a few hours; but a few survived into the second week. One lived thirteen days. Seventy-seven patients are known to have recovered; and in 5 the result is not recorded. Any disease with a death rate of over 63 per cent. must be considered extremely grave.

Treatment.—As in other affections whose pathology is not well understood, so in acute dilatation of the stomach, treatment must be largely empirical. Lavage of the stomach is the first indication. As Terrier has said, it is only a matter of common sense to empty an over-distended stomach. Regnier indeed employs lavage as a preventative of this complication, and at the first vomiting, the first hiccough, or change of expression, or increase in the pulse rate, at once washes the patient's stomach out. The idea which seems to possess the minds of a great many surgeons, that toxæmic symptoms after operation are due to stagnation in and absorption from the stomach, we think is in no way justified. Absorption from the stomach is so extremely slight that it seems doubtful that any recognizable symptoms of toxæmia can be produced in this way; but the importance of preventing the passage

of these secretions into the small intestine, whence absorption is rapid, has already been alluded to. Whatever the theory be, certainly the practice of washing the stomach is attended by the happiest results in all such cases. Yet it should not be made too much a matter of routine. Some patients will be so exhausted and nervously prostrated by the passage of a stomach tube that much more harm than good will ensue. It appears to us to be quite sufficient to employ lavage only when a distinct therapeutic end is to be attained. If every patient who hiccoughed or puked after an operation were to be submitted to lavage, the number who escaped such treatment would be inappreciable. Let lavage not be used until it is certain that the stomach cannot take care of itself; and then do not let any timidity prevent its employment even in patients who have been operated on by such methods as gastro-enterostomy or pylorectomy.

In case acute dilatation of the stomach is not promptly relieved by the first lavage, not only should this treatment be repeated, but the patient should be made to lie on the left side, with the foot of the bed raised so as to bring the pelvis higher than the diaphragm. This failing to secure relief, the "belly position" may be tried. In persistent cases, and where the nature of the operation does not contraindicate it, the patient should be made to assume the knee-chest position for fifteen minutes out of every two hours, as recommended by Zade. When such an operation has not already been performed, gastro-jejunostomy may be employed as a last resort. Of course, if on opening the abdomen, a kink at the pylorus or at the duodeno-jejunal juncture be found, which can be relieved without further interference, the surgeon should content himself with that; but in most of the reported cases it has been evident that no such simple procedure would have been productive of benefit. The operation proposed by Robinson—section of the duodenum and its reunion in front of the mesenteric vessels—is, as said by Finney, a thoroughly unpractical procedure.

Operative treatment of acute gastric dilatation appears to have been adopted in fourteen cases, with a mortality of over 85 per

cent. The operations employed may be seen in the following table.

OPERATIONS FOR ACUTE DILATATION OF THE STOMACH.

I. Exploratory Laparotomy: Abdomen closed without emptying Stomach.
   Jessop (Lancet, 1888, i, 726): Death.
   Robinson (Cincinnati Lancet-Clinic, 1900, xlv, 577): Death.
II. Exploratory Laparotomy, with emptying of Stomach by tube passed through Œsophagus, diagnosis not having been made before operation.
   Macevitt (N. Y. State Jour. of Med., 1906, vi, 284): Recovery.
   Turner (Appendicitis, Hernia, and Gastric Ulcer. London, 1905, p. 113): Death.
III. Reduction of Volvulus, dilatation of Stomach not being found at Operation.
   Lichtenstein (Zentralbl. f. Gynäk., 1906, No. 44): Death.
IV. Jejunopexy—kink of duodeno-jejunal flexure relieved by suturing jejunum to transverse mesocolon.
   Petit (Thèse de Paris, 1900; cited by Conner: Amer. Jour. Med. Sc., 1907, i, 345): Recovery.
V. Gastrotomy.
   Appel (Phila. Med. Jour., 1899, iv, 314): Death.
   Box and Wallace (Lancet, 1898, i, 1538): Death.
   Finney (Bost. Med. and Surg. Jour., 1907, clv, 107): Death.
   Hoffmann (Münch. med. Woch., 1904, li, 2003): Death.
   Wright (Practitioner, 1897, vi, 598): Death.
VI. Gastrostomy, the dilated Stomach being mistaken for a pancreatic cyst.
   Brown (Lancet, 1899, ii, 1017): Death.
VII. Gastro-jejunostomy.
   Kehr (Arch. f. klin. Chir., 1897, lviii, 632): Death.
   Körte (Deutsch. med. Woch., 1904, xxx, 1554): Death.

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Atonic Dilatation of the stomach, or **Gastric Myasthenia,** though formerly a well recognized affection of the stomach, has of late years become a disease of the utmost rarity. This is largely due to the increased accuracy in diagnosis of gastric affections to which physicians have attained, but in no small measure is it due to modern surgery which has proved by the living pathology of the operating table that most of the cases formerly classed as atonic dilatation are really examples of gastric dilatation due to well defined lesions, chiefly to pyloric obstruction from carcinoma, ulceration or perigastric adhesions. There is, of course, no inherent improbability in the muscular wall of the stomach losing its strength, just as we know that of the sigmoid flexure or of the colon higher up sometimes does; and just as we meet with cases of so-called atony of the bladder. Before diagnosis in urinary diseases was as fully developed as it is now, patients with atony of the bladder were frequently seen; but since diseases of the prostate have become more widely studied, and since sclerosis of the neck of the bladder has become a surgical entity, the cases in which the diagnosis of atony of the bladder is made have become correspondingly decreased in number. Indeed, for our own part, were we to encounter again a patient with pure atony of the bladder, from no recognizable lesion other than pure weakness of the vesical walls, or impairment of innervation, we should be rather disposed to question our own diagnostic acumen than to admit that such a state of affairs actually existed. So it is with cases of gastric myasthenia. There is no doubt that after such debilitating disease as typhoid fever the gastric walls may become weakened, and become readily subject to distention and dilatation when overloaded; but even in cases such as these, there is no good reason to suppose that recovery, if not attained by medical measures, may not be aided by operative means. Long-standing gastritis, originally catarrhal in form, may eventually invade the submucosa, thickening and hardening the gastric walls, and thus materially interfering with peristalsis. In the same manner, but even more noticeably, ulcerations, cancerous growths, and even the ingestion of poisons, may greatly impair gastric motility without in any way

producing stenosis of the pylorus. It is not impossible that the gastric nerves may be the seat of disease, without there being any change in the gastric wall itself, and that by this means dilatation may ensue from loss of motility. But such a change is probably much rarer than it has heretofore been considered. Actual degenerative changes (colloid, fatty, etc.) in the muscle fibres of the gastric walls are probably of less unfrequent occurrence.

In patients with this form of gastric dilatation, the absence of distinct history is the chief means of differentiating the disease from that form due to pyloric stenosis. The symptoms for which the patient seeks relief are the same in kind, though probably less in degree, than in pyloric stenosis. The sense of fullness persisting from one meal to the next, the anorexia, the thirst, the gaseous distention, and the eructation—all are the same in both affections.

Three stages of gastric myasthenia may be recognized. The first is **the stage of compensation,** the second that of **stagnation,** and the third that of **retention.** Early in the disease the symptoms are not of such prominence as to fix themselves in the patient's mind; it is only after an unusually heavy meal, or after a particularly indigestible one, that he is made aware of his dyspepsia. The gaseous distention then becomes oppressive, the clothing is perhaps unconsciously loosened, and relief is eventually obtained by the belching of gas, or by the lazy emptying of the wearied stomach into the duodenum. Not unfrequently a little sour fluid rises into the mouth along with the gas (VanValzah and Nisbet). But in this stage compensation is generally sufficient, and these periods of broken compensation arise only when some unusual strain is thrown upon the stomach. This stage may last for months or years; but it is exceedingly prone to pass into the second stage — that of gastric stagnation, a condition in which the stomach is unable completely to evacuate its contents between meals, except between the evening meal and breakfast, an interval sufficiently great for evacuation to be accomplished. The patient finds it impossible to gain in weight, though it is not usual for weight to be lost. Digestion, though delayed, is eventually completed. When, however, the third stage, that of retention, is reached, ema-

ciation commences and may become extreme. The stomach is not emptied even during the night, and lavage before breakfast will detect particles of food still in the stomach; and the gastric contents will possess the usual characteristics of retention—they will be sour, rancid, and usually very acid. Occasionally, when atrophy of the mucous membrane is present, the contents are neutral or alkaline in reaction. The evidences of fermentation are pronounced, and the production of gas will continue oftentimes after the stomach contents have been removed by lavage, as is evidenced by the separation of these contents into the usual three layers. The dilated stomach, by dragging on the pylorus, causes a kinking near the latter, thus adding the mechanical factor of actual obstruction to the myasthenia which was the primary cause of the dilatation.

Secondary nervous symptoms are of common occurrence in patients suffering from gastric retention due to atonic dilatation. As pointed out by Van Valzah and Nisbet, the source of these symptoms is to be found in intestinal toxæmia. The intestines partake of the atony which affects the stomach, and it is precisely because there is no pyloric obstruction that the fermenting gastric contents in part reach the small bowels, and are thence absorbed. Where the gastric dilatation is due merely to mechanical obstruction at the pylorus, this obstruction itself protects the small bowels from the decaying food, and the various symptoms of hypochondriasis, hallucinations, dyspnœa, tachycardia, urticaria, erythema fugax, and other toxæmic affections are the exception rather than the rule.

Treatment.—The treatment of gastric myasthenia in its earlier stages should be medical. If the first stage be recognized it oftentimes may be cured, or the developement of the second may at least be indefinitely postponed, by regulation of the diet and tonic treatment. During the second stage, in addition to the above, lavage is indicated; and electricity may be employed with some hope of benefit. But when once the stage is reached where weight is progressively lost, and where relative pyloric obstruction is present (either from kinking or from relative stenosis of this orifice of the stomach), then purely medical measures no longer will be

found efficient. It is rarely possible by medical means even to keep the patient from losing more ground, let alone improving him. In such cases as these we think operation should be undertaken, provided no contraindication to any operation exists; but the patient must not be led to expect an immediate cure. Probably the most that surgery can do is to so alter the mechanics of the stomach and intestines that medical measures will become effective. Hence it is to be anticipated that a prolonged course of medical treatment will have to be carried out after the operation has been performed.

As to the special form of operation to be employed, it is at present the consensus of opinion that gastro-jejunostomy is the best. We rather suspect, however, that before many years are past, surgeons will more generally adopt Finney's pyloroplasty either alone, or combined with some form of gastroplication. It is difficult to decide upon the respective merits of these two methods, because, as already remarked, we do not anticipate the phenomenally rapid amelioration of symptoms after operation for this condition that we do in cases of pyloric obstruction without marked atony; and too many medical men are inclined to give credit for the slowly acquired improvement solely to the medical treatment employed, when there can be no doubt, at least so it seems to us, that without the operation which improved the receptivity of the gastro-intestinal tract, food and drugs would have been of as little avail as they were before the patient was brought to the surgeon. Our own preference at present in such cases is for gastro-jejunostomy, because, in our judgement, as we have already pointed out (p. 113), Finney's operation should be limited to cases in which gastric motility is preserved; but as far as one can judge of the tide of surgical opinion, it is now setting in in favour of plastic operations on the pylorus for these patients, and becoming gradually opposed to gastro-jejunostomy for any but obstructive cases.

Secondary Gastric Dilatation.—In dealing with this condition the surgeon must never lose sight of the fact that it is not a distinct disease. Ever before his eyes must be the picture of a stomach that has become dilated after ineffectual efforts to overcome an obstruction to its evacuation. Only in this way will he be able to appreciate the seriousness of that stage of the disease at which his unfortunate patient has arrived. Were medical treatment always effectual in treating the disease, even when instituted at the commencement of the malady, the surgeon would never see any patients with gastric dilatation. It is the terminal stage of a serious disease, and as such is the gravest stage. The patient may have been in danger from hemorrhage or from threatened perforation at earlier periods of his malady; but in addition to these dangers, which, though perhaps less imminent, still persist, he is now afflicted with the most serious complication of all, save that of carcinomatous association. And gastric dilatation due to benign obstruction is less serious than gastric carcinoma only because patients with the former disease die more slowly than do those with cancer. Without surgical relief, both diseases are equally fatal, and irremediably so. Cancer usually kills in a shorter time, but death in benign gastric dilatation is quite as sure even if longer delayed.

Causes.—Although gastric dilatation in the immense majority of cases is caused either by *carcinoma* or by *ulceration* about the pylorus, yet in exceptional instances other factors are operative, and should therefore be borne in mind. It is well to remember, also, that *changes in the duodenum,* similar to those occurring at the pylorus itself, are not unfrequently productive of gastric dilatation. Especially is this true of ulceration and cicatrization above the ampulla of Vater; but ulcers even below this site, as well as other affections of the duodenum similar to those implicating the pylorus, may also cause dilatation of the stomach.

Systematic writers are in the habit of classifying the causes of obstruction here, as elsewhere in the alimentary tract, as those from changes in the wall of the pylorus, those within the lumen of the canal, and those which cause obstruction by distortion or

pressure from without. Among the changes in the pyloric wall itself, the developement of carcinoma probably holds first place in the production of gastric dilatation. It will be more fully considered in a subsequent chapter. Next to carcinoma, pyloric obstruction, and consequently gastric dilatation, is most frequently due to hyperplastic or cicatricial changes produced by benign ulceration. As will be presently pointed out, a temporary pyloric obstruction may be caused by hyperplastic ulceration at the pylorus, and later in the course of the ulcer's evolution the hyperplasia may subside, and the pylorus again become patent for a short time. At this stage the symptoms of gastric ulcer may temporarily disappear, and the patient may consider himself cured. At a later date, however, the latent ulcer will again give evidence of its existence, when by its cicatricial contraction the pylorus again becomes obstructed, this time permanently. The earlier and temporary obstruction usually does not cause gastric dilatation; it is rather productive of increased peristalsis, with hypertrophy of the muscular walls, and is frequently accompanied by pylorospasm, gastrospasm, and peristaltic unrest of the stomach (see p. 143).

Apart from these two changes—carcinomatous and ulcerative—there are few others taking place within the walls of the gastro-duodenal canal which are ever productive of secondary dilatation of the stomach. Yet Moullin has called particular attention to fibrosis of the pylorus without evidence of past or present ulceration, as a cause of stenosis; and similar cases have come under Dr. Deaver's care at the German Hospital. Causes of obstruction acting from within the gastro-duodenal canal are very rarely causes of gastric dilatation. The pylorus may be obstructed by foreign bodies, or by hair balls, or by concretions due to medicines such as bismuth administered in large quantities or over long periods of time; but it is extremely unusual for such agents to cause any but intermittent obstruction of the pylorus. The same is true of such pathological changes as gastric polypus (see p. 221), and hydatid cysts in the region of the pylorus. Pylorospasm may be the only evidences of such changes.

But the agents are many which from without the alimentary

canal may cause gastric dilatation by means of pyloric or duodenal obstruction. Not only may *adhesions* act in this manner, but a *distended gall bladder*, or a large *biliary* or *pancreatic calculus* may similarly be productive of dilatation of the stomach. *Chronic pancreatitis*, and *cancer of the head of the pancreas* may so obstruct the duodenum as to cause secondary gastric dilatation. *Enlarged glands* in the portal fissure of the liver, or along the common bile-duct, as well as retroperitoneal tumors, aneurisms, etc., may all in exceptional cases be productive of secondary gastric dilatation. Moreover, in addition to such causes, the *displacements* of the various abdominal organs may eventually lead to the same result. The influence exerted by a *floating kidney* is somewhat hypothetical in this respect; but there is good evidence for believing that displacements of the *liver* due to tight lacing or other causes may be productive of dilatation of the stomach. The *modus operandi* of the change is not always easy to detect; but it probably is either by directly obstructing the pylorus, or by first producing gastroptosis, which in turn brings about a kinking of the pylorus. The latter explanation is, we believe, the more probable, and it has been our habit to teach that the proptosed stomach is always dilated. Such at least has been our experience at operation.

Perigastric adhesions—or **perigastritis,** as the condition was called when it was considered a distinct disease, analogous to perityphlitis—are due to a variety of causes. The adhesions, however, which are productive of gastric dilatation are usually to be traced to affections of the biliary tract. Indeed, disease of the biliary tract is in many instances the origin of the whole chain of gastric disorders. This connection has already been noted (page 69). In a smaller number of instances, perigastric adhesions causing pyloric obstruction have arisen in attacks of plastic peritonitis due to gastric ulcers themselves; and in exceptional cases are due to previous attacks of peritonitis from other causes. A glance at Figure 21 (Andrews) will show how disabling these adhesions may become.

Clinical Pathology.—The changes occurring in the pylorus and the stomach in this disease are reflected with fair accuracy in the symptoms which are observed. In the early stages of gas-

tric ulceration there frequently occurs such hyperplastic reaction as to cause obstruction of the pylorus, if not to produce a palpable tumor. Such inflammatory masses as these, producing pyloric obstruction, and simulating a malignant tumor, have on several

FIG. 21.—PERIGASTRIC ADHESIONS, INVOLVING GALL-BLADDER, COLON, AND SIGMOID FLEXURE.
The small intestine has been cut away.

occasions (see p. 117) led surgeons to the performance of gastro-jejunostomy, in the expectation that the patient would thus obtain some little respite from imminent death. In such cases great has been the surprise of the surgeon and the joy of the patient to observe after a few months that the suspected tumor has melted away, as it

were, the relief obtained by means of the operation enabling nature to produce a cure of the disease. If no operation had been performed at that time, one of three courses might have been pursued by the disease. The first and most usual course, we think, would be that under appropriate medical treatment sufficient rest would have been obtained by the inflamed area for a decrease in the obstruction to have occurred, with a subsidence of the symptoms of peristaltic unrest of the stomach. This would be only a temporary lull, however, whereas after a gastro-jejunostomy we should have reason to expect a cure. The second course might have been for the obstruction to persist and to lead without delay to gastric dilatation; while the third course, and one which we are satisfied is less rare than that just mentioned, would be for the hyperplastic area to undergo malignant change, whether or not a temporary lull occurred in the evolution of the disease under medical treatment.

If the obstruction of the pylorus, due to the hyperplastic process, decreased under medical treatment, the symptoms would naturally abate, and the patient, and the physician as well, would naturally regard the disease as cured. But in the vast majority of such cases there comes a time, perhaps months or even years later, when the gastric ulcer in its course of cicatrization and contraction again narrows the pyloric orifice, and when the old stomach symptoms begin afresh. It is at this stage of the disease that secondary dilatations are most frequently seen.

When due attention is paid to the various causes of pyloric obstruction, it is not difficult to picture the course which the disease will pursue in each individual case. As a rule, a temporary gastric hypertrophy occurs, with increased peristalsis, and for a time the obstacle may be overcome. Sooner or later, however, the gastric walls yield, and from the stage of compensation that of stagnation is reached, and this finally drifts into absolute retention. The downhill course is most rapid in malignant pyloric obstruction; but with judicious medical treatment it may, in patients with benign obstruction, extend over a period of years.

Symptoms.—The symptoms of secondary dilatation of the stomach are usually sufficiently pronounced. In the earlier stages

of the disease, when compensation is present, or even later, when stagnation has commenced, the symptoms are less distinct; but when once retention has developed, there is slight probability of making a wrong diagnosis.

The **subjective symptoms** are much the same as those which have already been described under atonic dilatation of the stomach. But the *previous clinical history* of the patient will usually throw much light upon the diagnosis. Usually the patient at an earlier date has presented symptoms of gastric or duodenal ulcer; and possibly there has occurred a lull in the evolution of the disease, when the ulcer was healing or had actually healed, and before it had contracted, or while the tone of the gastric walls was still sufficient to compensate for the slight obstruction present. After this temporary abeyance of symptoms, there will gradually be developed the *sense of fullness* persisting after meals, perhaps even to the time of the next meal, and thus leading to *anorexia*. Because fluids are not absorbed from the stomach, and because in the stages of stagnation and retention they are late in reaching the small intestine, if they reach it at all, there is more or less *constant thirst*. As the dilatation progresses, and as stagnation becomes extreme, the dilating stomach occasionally makes the attempt to empty itself by the act of *vomiting*. Generally it is an ineffectual attempt, some of the stomach contents not being expelled; but this partial evacuation procures an intermission in the nausea for a couple of days. The very fact that ingestion of food does not always provoke emesis shows that the ulceration has passed the irritable stage; and the copious and cumulative vomiting which recurs every second or third or fourth day is, in itself, very good evidence that the stomach is dilated.

To these usual symptoms should be added one less usual, but of increasingly frequent occurrence in these last years, when the pathology of gastric disorders has become better understood. We refer to *gastric tetany*, which may, we think, be most appropriately considered as a symptom of dilatation of the stomach. It is a subject which has received special attention from Mayo Robson; indeed one can scarcely avoid the conclusion, at which we have

ourselves arrived, after a somewhat extensive study of the literature, that tetany is more often of gastro-intestinal origin than due to any other cause. It is needless to dwell here upon its symptoms, as they are detailed in every text book of medicine, nor on the various theories as to its cause; it is sufficient for the surgeon that he be cautioned to let no such case pass from surgical into medical care until he has positively ascertained that the affection is not associated with, even if not immediately caused by, gastric dilatation. Auto-intoxication without intestinal putrefaction is admittedly rare, as has already been pointed out (p. 159). But the frequent association of tetany with secondary gastric dilatation is too patent to be overlooked; and even in one case of infantile pyloric stenosis, tetany was a prominent symptom (p. 138). McKendrick asserts that there are on record about 63 cases of tetany, which are clearly due to gastric dilatation.

According to some authorities, *Globus Hystericus* is frequently due to the drag on the œsophagus exerted by a dilated or proptosed stomach.

The **objective symptoms** are even more characteristic than are the subjective. The *capacity of the stomach* is seen to be increased, not only from the excessive amount of matter vomited, but from the amount of fluid that may be introduced through the stomach tube. Dilatation of the stomach with air will also make its great size apparent. In men the dilatation is more horizontal, while in women the increase in size is chiefly toward the pelvis. The level of the greater curvature is practically always found below the umbilicus, and in women it not unfrequently reaches to the symphysis pubis. The dilatation with air should be very gradually done by means of a hand bulb attached to the stomach tube. The stomach should meanwhile be lightly percussed and the sensations of the patient should be the infallible guide as to the limit of distention to be produced. While in cases of open ulcer we think even the passage of a stomach tube should be avoided in most cases on account of the possibility of exciting hemorrhage or producing a perforation, in secondary dilatation of the stomach we think no damage can be done, provided common sense is ex-

ercised and the manipulations are carried out with gentleness and patience. Hurry should be avoided above all things; it is under such circumstances the equivalent of violence. The use of a Seidlitz powder, its separate parts administered at short intervals one after the other, may be more agreeable in anticipation to the patient, but it is a dangerous and uncontrollable remedy, and as such should be avoided. It is impossible to determine beforehand either the force of the effervescence or the capacity of the stomach; and while we are well aware that this means of distention has been employed many more times safely than with disaster (see p. 326), yet it is a method which in our opinion is barbaric in its simplicity. The determination of the outlines of the stomach by means of *skiagraphy*, after the administration of an emulsion of bismuth, has met with a fair amount of success in the hands of various practitioners. The method has been employed also in gastroptosis, and allied conditions (Worden).

The examination of the *contents of the stomach* reveals the usual fermentative and putrefactive changes of gastric retention. The fluid withdrawn settles into three layers—the lowest of semi-solid matter, the middle of clear or slightly cloudy yellow fluid, while the topmost layer is extremely frothy, due to the gas-producing ferments and micro-organisms.

The *fæces* of the normal individual contain from 4 to 6 ounces of solid matter in twenty-four hours, and about 75 per cent. of water. As a result of the lessened absorption which occurs in gastric dilatation, the amount of solids decreases to one and a half or two and a half ounces, and the proportion of water falls as low as 40 or even 30 per cent.

The *urine* is also much diminished in quantity, and the amount of uræa and chlorides is decreased.

Diagnosis and Differential Diagnosis.—As has already been mentioned, extreme degrees of gastric dilatation are seldom mistaken for other affections. It is in the early stages—those of compensation and mild stagnation that the disease is most frequently overlooked. Such patients are classed as dyspeptics, and are treated in our dispensaries for chronic gastritis; the diagnosis is

based on the symptoms alone, without any attempt being made to trace the evolution of the disease or to apply to it the principles of physical examination of the secretions, and their digestive power —methods of study which are nevertheless constantly employed in studying the kidneys, the cardio-vascular system, and the lungs. It is in these early stages that the pathologist's findings from examination of the gastric contents may give the first clue as to the nature of the disease. But it is only a clue, and should be so regarded. Were these chronic dyspeptics studied with the care their sufferings merit, the dispensaries of our hospitals would have fewer return visits, but more patients would be permanently cured of their maladies by surgical means, before their strength and vitality had ebbed so low that scarcely with forced feeding and stimulation will many of them be brought to the condition where they may be considered good operative risks.

When the early stages of gastric dilatation are once recognized, it next becomes important to determine the cause of the dilatation; for as we have already seen, there exist two distinct groups of gastric dilatation, the atonic and the obstructive. The former is rare, and it is our belief that it grows rarer every year, as more patients are subjected to operation, and as the surgeon is given more opportunities to show that the disease is really of an obstructive nature.

With due attention to the previous history of the patient and strict inquiry into the clinical course of the present illness, of which illness gastric dilatation is a stage, it will in most instances be quite possible to draw a distinction between myasthenic and obstructive dilatation of the stomach. When the symptoms of gastric dilatation appear after a distinct period of gastric trouble, whether immediately or remotely preceding the present symptoms, obstruction is almost certainly the cause. If the dilatation has developed rapidly, in the course of a few weeks or months, without a long history of preceding gastric indigestion, especially if the patient be past early adult life, malignant disease is probable. When no preceding indigestion, typical of gastric or duodenal ulcer, or of biliary infection, has annoyed the patient over a long period

of time—when, in short, the clinical history is negative—then it is rather probable we have to do with a case of myasthenic dilatation. A point in the differentiation of obstructive from atonic dilatation of the stomach, on which much stress is laid by Van Valzah and Nisbet, is that in the former variety of dilatation solids are much more obstructed than are liquids; and on this account toxæmic symptoms are less usual than in atonic dilatation, in which latter affection the fermenting stomach contents every now and again are discharged into the intestinal canal, whence they may be absorbed. In obstructive dilatation fluids are evacuated rapidly compared to the rate of evacuation of solids, so long as the stages of compensation and stagnation persist; and Van Valzah and Nisbet claim that in this disease (obstructive dilatation) if a pint of water be given when the stomach is empty, it will be evacuated within one hour and a half, or long before the atonic (myasthenic) stomach "ceases to splash or to yield water upon the introduction of the tube." Atonic dilatation, they remark, was once called the "dyspepsia of liquids."

In myasthenia pain and vomiting are exceptional; in obstruction pain is a prominent feature, especially when perigastritis exists, and copious vomiting every few days is the rule. Finally, myasthenic dilatation is usually considerably relieved within a reasonable time by medical treatment, while the obstructive form grows progressively worse, even when such treatment is instituted in the early stages.

Dilatation of the stomach must not be confounded with a *simple large stomach*, whether it be congenitally of an abnormally large size, or due to long continued overfilling. In such a stomach an attack of gastritis, due to some unusual indiscretion in eating or drinking, may simulate for a time gastric dilatation. But the inflammation in such cases is quickly relieved by functional rest and medical treatment, which is not the case where the stomach is dilated.

Gastroptosis is another affection which may cause rather vague symptoms of indigestion. But the surgeon who is acute in eliciting a patient's clinical history will not easily be misled into mistaking

gastric dilatation for gastroptosis or *vice versa*. Because in the case of obstructive dilatation it is exceedingly rare for the clinical history to be negative; while in uncomplicated cases of gastroptosis it is the rule. In uncomplicated cases of gastroptosis, we say; for it has been our experience that the proptosed stomach is always dilated, unless it forms a part of a general visceroptosis.

Prognosis.—In secondary gastric dilatation the prognosis is bad, unless the mechanical obstruction be relieved by mechanical means. All that was said on the prognosis of gastric ulcer in general, should be borne in mind in this connection. It was there (p. 100) pointed out that under the best medical treatment the death-rate from gastric ulcer in general is at least 8 per cent., with a large proportion of relapses; but that after timely operation, all but from two to five per cent. of the patients recover, and most of them remain permanently cured. The statistics from which these conclusions were drawn included not alone cases of open gastric ulcer, but those cases where the stomach was very extensively diseased—dilated, distorted, or contracted as a result of chronic ulceration. We possess, unfortunately, no series of statistics by which we can compare the results in patients with gastric dilatation who have been treated medically, with those obtained in the same class of patients after operation. The large masses of statistics hitherto published include all stages of gastric ulcer; and it is only because gastric dilatation is a more serious affection than gastric ulcer without dilatation that conclusions which are justly drawn from statistics of the disease in general, apply with greater force to its more serious aspects. But in the case of **gastric tetany,** we may speak in figures with some authority. This affection enjoys a mortality under medical treatment of from 70 to 80 per cent. Although few operations so far have been done for its relief, and though the mortality is severe, yet when compared to the figures just given it is low. Cunningham collected 8 operations for gastric tetany, with 5 recoveries and 3 deaths, a mortality of 37.5 per cent. To these McKendrick has recently added 16 successful cases, making a total of 24 operations with only 3 deaths, a mortality of only 12.5 per cent. In the three fatal cases (reported by

Fleiner (2 cases), and Gumprecht), death was due to visceral disease, to pneumonia, and to peritonitis.

But it must also be remembered that where a mechanical obstacle exists to the evacuation of the stomach it will be only a question of time until the patient starves to death even under the most energetic medical treatment. The starvation is slow, and it is barely possible that the patient will not recognize the fact that he is starving to death; but the intelligent onlooker, be he physician or layman, appreciates the true seriousness of the patient's condition; and it is no longer necessary for the surgeon to urge that in such cases surgery affords the only escape from death. What the surgeon still urges, is that the operation shall be undertaken while yet there is sufficient recuperative power left in the body cells of the wretched patient. Perhaps the day will come, but it has not yet dawned, when the surgeon will no longer need to urge even this, but when all physicians will, as at the present time the most progressive of them do, invite the surgeon to see their stomach cases with them, in order that they may decide, in the light of the knowledge the physician can shed on the case, not only whether an operation is required, but also at what period of the disease it had best be undertaken. We have no hesitation whatever in saying that when obstructive dilatation of the stomach is once diagnosed, all delay should be avoided, and surgery should at once remedy the mechanical defect which Nature and her handmaid Medicine are unable to remove.

Treatment.—The choice of operation lies between gastro-jejunostomy, pylorectomy, and pyloroplasty. Unless a justifiable suspicion of malignancy is entertained, we think pylorectomy for gastric dilatation is to be condemned. We should propose excision only in an extremely small number of these cases. We believe that gastro-jejunostomy will continue to give in the future, as it has in the past, the best results; and that Finney's operation should be reserved for those patients in whom gastric motility is but slightly impaired. This would limit its application to gastric dilatation to the earliest stages of the disease. It is certain, moreover, that gastro-jejunostomy gives more immediately gratifying

results in patients whose pylorus is almost impassable even to liquids; and that in the earlier stages of dilatation, where the pylorus is still slightly patent, gastro-jejunostomy will at times fail as a primary procedure, and that the surgeon may sometimes be forced to ligate the pylorus as a secondary operation.

Exclusion of the Pylorus, first employed in 1895 by von Eiselsberg, has recently been advocated by Jonnesco. The operation consists in sectioning the stomach in the prepyloric portion, closing both ends, and performing posterior trans-mesocolic gastro-jejunostomy. We do not see that it presents any advantages over simple ligation of the pylorus, though we agree with Jonnesco's statement that it is a better operation for open ulcer than pylorectomy. Jonnesco reports 9 such operations done during 1906 and 1907; all the patients recovered from the operation, but one died on the eighth day from hemorrhage; the others were permanently cured. Von Eiselsberg employed exclusion of the pylorus 4 times, all the patients recovering, but one dying eight months later from hemorrhage; the other patients were much improved.

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GASTROPTOSIS.

Gastroptosis, a condition in which the whole stomach is displaced downward, sometimes requires surgical treatment. The causes of the affection are obscure. Glénard, in 1885, drew attention to general visceral prolapse involving, besides the stomach, the intestines, usually the right kidney, and sometimes the liver and spleen as well. To account for these changes, various theories, none of them very satisfactory, have been advanced. Only a few ætiological factors seem to be susceptible of demonstration. It is a condition which is very much more frequent in females, and good reasons exist why this should be so. Apart from the influence of the clothing of that sex, including the use of corsets, the practice of tight lacing, and of suspending heavy skirts from the waist instead of from the shoulders or hips, there are the well known influences of pregnancy and repeated childbirths in relaxing the abdominal walls and weakening the pelvic floor. All these mechanical factors tend to allow a descent of the structures in the upper abdomen. Scoliosis, and other deformities of the skeleton which reduce the area of the upper abdominal regions, are also considered by some to be causes of gastroptosis. Sudden loss of flesh, as in wasting diseases, such as typhoid fever and severe attacks of influenza, is

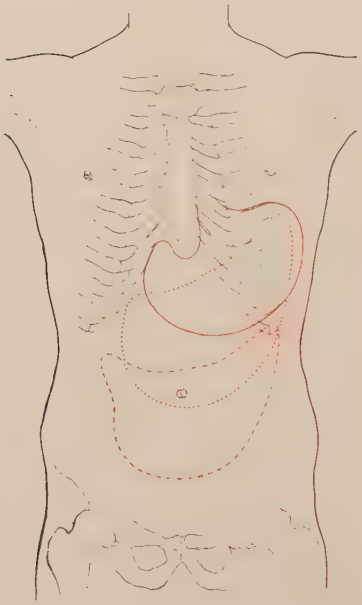

Fig. 22.—Various Degrees of Gastroptosis.

thought, and sometimes with apparent good reason, to be a cause of gastroptosis. The influence which a dilated stomach exerts, both by its weight and its atony, has been too little appreciated; and when once gastroptosis is added to dilatation, food stagnation is mechanically favoured, and one condition continues to aggravate the other.

The **clinical pathology** of gastroptosis is of some importance. Kelling divides gastroptosis into three groups: (1) Where the greater curvature of the stomach is still above the umbilicus; (2) where the lesser curvature is still above, though the greater has descended below the navel; and (3) where even the lesser curvature has passed below the umbilicus. The stomach is usually dilated; indeed we have never seen a patient with gastroptosis without dilatation of the stomach, unless the gastroptosis was only a part of a general splanchnoptosis. Among 32 cases of gastroptosis studied by Worden there were only 3 in which the stomach was not dilated. The gastro-hepatic and gastro-phrenic omenta are stretched; the stomach becomes more or less horizontal, lying in the transverse rather than in the longitudinal axis of the body; and in extreme cases the pylorus itself descends, dragging the first and second portions of the duodenum with it. The transverse duodenum is usually so securely fixed that its position does not change, but sometimes it is found lower than normal, crossing the fourth, or fifth, instead of the third, lumbar vertebra. These changes naturally are prone to cause a kinking of the pylorus, and will add to the gastric dilatation usually present. A floating kidney, which by its weight displaces the duodenum and transverse colon, is a well recognized factor in the developement of gastroptosis.

The **symptoms** of gastroptosis are occasionally absent, even when the displacement is well marked. In other patients a very slight degree of gastroptosis causes very distressing and disabling symptoms. Those of neurasthenia are frequently more pronounced than the symptoms referable to the stomach itself. In general the symptoms resemble those of dilated stomach. There is flatulence after eating, occasionally so pronounced as to constitute

peristaltic unrest of the stomach. The clothes are loosened and in severe cases the reclining position is habitually assumed after meals. Large meals are avoided; and so painful may the process of digestion become that patients will almost starve themselves rather than endure it. Emaciation is the usual sequel. The pain is a tearing or a stretching sensation, as a rule easily distinguishable from the intense boring pain of gastric ulcer or cancer.

From symptoms alone it is rarely possible to reach an accurate diagnosis. **Physical examination** is much more satisfactory. *Inspection* of the abdomen, with the patient standing, usually reveals a protruding lower abdomen, not due to fat, for these patients are usually emaciated, but to the descent of the stomach from the epigastric to the umbilical or hypogastric regions. The epigastrium is empty and hollow, and frequently the pulsations of the aorta are visible below the ensiform process. On palpation this pulsation can almost always be felt with abnormal distinctness. The contour of the lower chest, showing the effects of corset pressure, is of diagnostic value. Some authors have insisted upon the mobility of the tenth rib, as a predisposing cause, allowing undue pressure upon the liver, and through it displacing the stomach. *Palpation and percussion*, especially when the stomach has been distended with air or fluid, will readily enable the examiner to outline the greater curvature, and in severe cases the lesser curvature also may be detected in this manner. *Skiagraphy*, with the aid of emulsions of bismuth, has been evoked by certain authors in the study and diagnosis of displacements of the stomach (Worden, Pfahler, Sailer, Pancoast). By its aid much of interest may be learned, though we incline to the opinion that a correct diagnosis may almost always be made without it.

Surgical treatment is rarely called for in cases of simple gastroptosis. When successful, it is rather because the stomach was dilated, and because by operation its motility is improved, than because the malposition is corrected.

Gastroplication, proposed as a remedy for dilated stomach in 1891 by Bircher, was first employed by Summers in 1897 in a case of gastroptosis.

Duret, in 1896, was the first to resort to operation for the relief of gastroptosis. He did a *gastropexy*, suturing the anterior gastric wall to the parietal peritoneum. Rovsing and Hartmann employed similar operations. A second method of operating by gastropexy was practised in 1897 by Beyea, who shortened the gastro-hepatic omentum by a series of interrupted sutures. About the same time Bier devised and employed a similar operation, though an account of his method was not published until later. Coffey sutured the root of the great omentum to the abdominal wall, thus giving support to the stomach from below. Rovsing, Kammerer and others surgeons have employed *gastro-jejunostomy*.

Our own preference has always been for gastro-jejunostomy, and for the reason already given, that we have never yet seen a case of simple gastroptosis in which gastrectasis was not also present. The relief of symptoms, in the patients on whom we have operated for gastroptosis, while gratifying, has not of course been so pronounced or so constant as in patients with dilatation of the stomach without gastroptosis. Many surgeons share in this preference for gastro-jejunostomy. Hammer, both from a review of the literature and from his personal experience, prefers gastro-jejunostomy to any other form of operation.

The objections to gastropexy by Duret's method are the interference with the motility of the stomach and the liability of the newly formed adhesions to cause more discomfort than the original disease. From these particular objections the method of Beyea is free, since the stomach is raised to approximately its normal position by shortening the gastro-hepatic omentum, without the formation of adhesions to the stomach itself. Beyea has recently stated that he has resorted to this operation in eight patients, all of whom were permanently benefitted by the procedure, except one, who suffered a return of symptoms after being overworked. E. B. Hodge, Jr., in one case successfully combined Beyea's operation with gastroplication. Yet in not a few patients return of symptoms after such procedures has necessitated a final resort to gastro-jejunostomy. The possibility of puncturing blood-vessels in the gastro-hepatic omentum has so far restrained us from adopting

this operation of Dr. Beyea's. Although we are not aware that any evil results have followed its performance, yet as gastro-jejunostomy has commended itself to us in both theory and practice, we feel constrained to advise its adoption rather than Beyea's operation, in case any operation should be determined upon. Many patients, moreover, with gastroptosis have the gastro-hepatic omentum so attenuated by the duration of the disease and the weight of the stomach, that sutures would be very likely to tear loose. Should Beyea's operation be employed, the horizontal position should be maintained for at least three weeks.

Finally it may be well to insist again upon the impropriety of performing any operation in the majority of cases of gastroptosis. Much comfort, indeed an almost complete relief from invalidism, may frequently be obtained by the use of a well fitting abdominal binder. An ill fitting belt is worse than useless. But where the neurotic symptoms are not excessive, and where constipation is extremely intractable, an emaciated wreck may sometimes be restored to a useful life by the simple operation of gastro-jejunostomy.

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CHAPTER VI.

BENIGN DISEASES OF THE STOMACH AND DUODENUM (Continued).

OBSTRUCTION OE THE CARDIAC ORIFICE OF THE STOMACH.

Congenital Imperforation of the Œsophagus.—Although this affection is extremely rare, and is seen rather by the pædiatrist than the general surgeon, yet it seems worthy of short notice in this chapter, inasmuch as gastrostomy or some similar operation presents the only hope of cure.

The subject has been well reviewed by Demoulin, who succeeded in collecting fifty recorded cases. The gastric portion of the œsophagus communicated with the trachea in 44 of these cases, and with the bronchi in 2 cases. It is therefore extremely unusual for the malformation to consist of a simple obstruction of the lumen of the œsophagus by a membrane, or even for the two portions of the œsophagus to lie in the same axis, connected by a fibrous band. The symptoms, which exist from the time the child begins to take nourishment, consist first in the constant and persistent regurgitation of food, and second in the recurrent attacks of smothering which are recognized as characteristic of the disease. These smotherings are due to the regurgitation of mucus and gastric juice into the air passages, through the gastric portion of the œsophagus. If the baby does not die of asphyxia in one of these attacks, pneumonia may occur from the regurgitation of gastric fluids, or from the inspiration of food. Inanition will quickly kill the infant should he escape other perils.

Operative treatment, according to Demoulin, was first suggested in 1866 by Tarnier, who proposed gastrostomy. Steel (1888) was the first to perform gastrostomy. His patient was twenty-four hours old, and died in twenty-four hours. In 1903 Robineau

again operated, on the third day of life, by gastrostomy; but his patient died on the third day. Villemin's case, reported by Demoulin, was operated on in 1904, at the age of three days, by gastrostomy; this patient lived five days after the operation. Kirmisson reported the fourth fatal case, operated on at the age of three days by gastrostomy. Putnam has added a fifth fatal case. Baudouin says that Veillard and Le Mée found, in 1906, six fatal gastrostomies recorded for this affection.

The question naturally arises, in view of the extent of the malformation, whether any operation can be expected to be of benefit. Broca has expressed himself as unalterably opposed to any operation on an infant so malformed.

In discussing Demoulin's paper, Broca gave as his opinion that death is the best solution of the difficulty; that he had been gratified to learn that all the patients operated on had died; and that on this account he was glad to study with Demoulin new and more complicated operations, because these will be still more certain to result in death. Never, he said in conclusion, would he assume the responsibility of putting into circulation in the world an infant with its mouth in the duodenum! To our mind, such an infant is no more of a monstrosity than one whose alimentary tract empties into the bladder, or possesses no opening at all at its lower extremity; and we fail to see why, if operation be justifiable in one case, it will not be equally so in the other. The surgeon is not an executioner. It is not for him to decide whether an individual is fit to live or not. His duty is to prolong his patient's life, and to use the agencies of modern surgery in the attempt to overcome deformities and to restore the malformed to a state as nearly normal as possible. It may be objected to this reasoning that a patient who already has a malformation of his œsophagus is rendered only more abnormal by the formation of a gastric fistula. Such a reply, we submit, is not argument, it is repartee. But it may be further argued, that even were the patient who has submitted to gastrostomy to survive the perils of infancy—that even were he to reach an age when a more serious operation might justifiably be undertaken—it might be said that even at that period of his life surgery

could offer no permanent solution of the difficulty; in other words that the restoration of an œsophagus whose upper end is a blind pouch, and whose lower end opens into the trachea, is a problem beyond the possibility of solution by surgery. For our own part, we do not take so narrow a view of the surgical possibilities of the future. We have, on the contrary, the utmost confidence that all problems of mere technique will ultimately be solved. We cannot, of course, hope to make a new œsophagus grow; but given the patient, fit for an operation for the restoration of such an œsophagus, and we doubt not that some surgeon will solve the problem of the technique. It may not be in Broca's time, nor even during our own lives; but we are none the less confident that such a time will come.* The surgery of the chest is younger even than the surgery of the stomach, which is about the youngest thing in surgery today; and though Sauerbruch's air chamber may not solve all the problems of intrathoracic operations, we are nearer by many steps to the goal than even ten years ago. We therefore give it as our unqualified opinion that, save in the already moribund, the surgeon is not only justified in resorting to operation, but he would be worthy of condemnation should he refuse to employ the skill he possesses in the attempt to give these patients a fighting chance for life.

Gastrostomy has heretofore been the only operation employed. On account of the danger of liquids, injected into the stomach by the gastric fistula, entering the lungs by way of the œsophageal communication, Demoulin suggested that jejunostomy would be a safer operation. If this could be safely combined with ligation of the pylorus, and gastrostomy as well, a state of affairs temporarily satisfactory might be obtained. If the pylorus were not ligated, bile and pancreatic juice, and possibly also the injected food stuffs,

* The above paragraphs were written before the publication (January, 1907) of the daring operation by which Roux of Lausanne seeks to form a new œsophagus by transplanting beneath the skin of the sternum a coil of the jejunum excluded from the intestinal tract; and also before the appearance of Baudouin's article, referred to above, where, being ignorant of Roux's operation, he proposed to connect an œsophagostomy opening in the neck, with a gastrostomy opening in the epigastrium, by means of a rubber tube, or some similar contrivance. (See page 359.)

might find their way into the stomach; and unless the stomach, even when excluded from the digestive tract, as by ligation of the pylorus, were drained exteriorly, it would still discharge its secretions into the trachea, and so threaten death from suffocation. Possibly gastro-jejunostomy combined with gastrostomy, by the method of Rutkowski and Witzel, might accomplish the same result. But any operation on infants a day or so of age must be simple and quick; and for these reasons we prefer gastrostomy. Roux's method of subcutaneous gastro-œsophageal anastomosis (p. 358) will afford the patient a chance for ultimate cure, should immediate death be averted.

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Cardiospasm.—Cardiospasm, an affection not of excessive rarity, is analogous to pylorospasm and gastrospasm. Gottstein refers to 145 cases, of which 25 came under his own care. Its pathology is obscure, but is probably much the same as that of the affections mentioned. A polyp was the cause in the case reported by Ledderhose. Mild cases probably often pass unperceived. The patient, usually a woman, from thirty to forty years of age, may feel that the food lodges a moment before entering the stomach; and the individual affected may be able to force it through voluntarily, by taking a long breath and contracting certain of the pharyngeal and œsophageal muscles. In more severe cases a pouch may develope, and the patient, eating little at a time, will form a habit of retiring to a quiet nook after taking food, and will there wrestle with the obstruction until it either gives way, or the distress occasioned is relieved by vomiting. The bougie in such cases will usually detect both the obstruction and the pouch. The diagnosis from cancer is best made by the symptoms: pain and hemorrhage being the most prominent symptoms of malignant disease of the cardia, while in cardiospasm pain is never severe, and hemorrhage is of the utmost rarity. Should the periodical passage of a bougie fail to relieve the condition, much may be hoped for from operation. But as the latter form of treatment is not free from risk, medical measures and the passage of bougies should be persisted in until there can be no doubt of their failure to relieve the affection.

Rosenheim employed balloon dilators, introduced through the œsophagus, in the treatment of this affection, and with a fair measure of success. One patient reported remained well for over two years. This method had been adopted formerly by Russell, and recently has been commended by Plummer, who employed it in 36 patients. The operation of divulsion of the cardia for cardiospasm is said by the late Prof. Ashhurst to have been employed by Loreta, v. Bergmann, Catani, Frattini, and Billroth. Mikulicz reported four patients as having been cured by the procedure. These cases were reported at intervals, respectively of 12, 6, 2, and 1 month after the operation, no recurrence of the trouble being noted in any case. Two later operations by Mikulicz also resulted in cure (Gottstein). Ledderhose's

patient, already referred to, recovered, after the removal of a polyp from the lower end of the œsophagus. Erdman and Martin have each reported a successful case of divulsion of the cardia, the operation having been performed twenty months and six months, respectively, before the reports were made. In a patient of W. J. Mayo's, mentioned by Plummer, relief for four months was obtained by divulsion of the cardia after gastrotomy.

After opening the stomach through its anterior wall the cardiac orifice is divulsed digitally (Mikulicz employed forceps with rubber covered blades) until two or even three fingers will readily enter the œsophagus. The stomach is then closed, replaced, and the abdominal wound repaired without drainage.

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Cicatricial Contraction of the Cardiac Orifice of the Stomach, from other than malignant disease, is so extremely rare that it need only be mentioned in passing. When, as is less unfrequently the case, it is caused by the ingestion of corrosive liquids, the symptoms are overshadowed by those of œsophageal stricture, but when this tube is not involved, the usual symptoms of cardiac obstruction are present, but without the cachexia which so early developes in cancer. If bougies fail to keep the passage open, gastrostomy may be done, and the cardia may be cautiously dilated instrumentally or by the fingers, and retrograde passage of a bougie attempted. Much good may ensue, as in stricture of the œsophagus, from attaching a string to the bougie, and drawing it out of the mouth. The stricture may then be sawed by means of the string, whose two ends, passing from the mouth and the gastrostomy wound, may be tied together and thus kept safely in place. Or gradually increasing sizes of rubber tubing may be drawn through the stricture by means of the string. It is well in any case to keep the gastric fistula patulous for a number of months; it may be used from time to time while some passing irritation of the cardia is subsiding, and until nourishment may be taken again in the usual way. Mayo Robson refers to two patients of his living some years after a gastrostomy performed under these conditions, and he states that they still occasionally make use of the gastric fistula, and find no inconvenience in its existence.

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CHAPTER VII.

HOUR-GLASS STOMACH AND GASTRIC DIVERTICULA.

Hour-glass Stomach.—This term well describes the condition found in the immense majority of patients in whom the stomach is loculated; but as cases are occasionally observed in which three (Moynihan, Paterson, Kausch, Schmitt) and even five pouches (Klein) exist, the term segmented stomach, advocated by Wölfler, is more generally applicable. And as diverticula of the stomach are produced by essentially the same causes as those operative in cases of hour-glass contraction, it is convenient to consider them both in the same chapter.

The condition, first noted by Amyand, was subsequently described by Morgagni. The earlier writers on the subject, and those even until recent years, considered it a congenital anomaly in the vast majority of cases. Later writers, notably Moynihan, have proved that as a congenital deformity it is of the utmost rarity, if indeed not altogether unknown. Moynihan is not willing to accept as genuine examples of congenital deformity any of the cases whose records he has examined, nor has his study of museum specimens altered his opinion. Delamare and Dieulafé have recently recorded the case of a bilocular stomach in a new born baby, born of syphilitic parents, but with no syphilitic lesions itself; in this case the only lesion found, even on microscopical examination, consisted in hypertrophy of the muscular coat at the junction of the cardiac and the pre-pyloric portions. Gardiner observed hour-glass contraction of the stomach, associated with an *accessory pancreas*, at autopsy on a child of three months old. It must further be remarked that as recent anatomo-physiological researches have called renewed attention to the stomach, we realize the truthfulness, heretofore almost forgotten, of the descriptions of normal stomachs long ago made by Home, Cruveilhier, Henle,

and others; and we are thus able to explain as normal many appearances found post-mortem which were at one time considered pathological (See Chap. II, p. 47). Moreover, even in cases of hour-glass stomach observed in infants and young children, it may be quite possible for the deformity to be explained as due to pre-existent disease of the stomach in infantile or intrauterine life.

While, therefore, it cannot be categorically denied that such a thing as a congenital hour-glass stomach may occur, it must be acknowledged to be of extreme rarity; and any cases reported as such deserve prolonged and critical investigation.

Schomerus found that among 1014 operations for gastric lesions, 71 or 7 per cent. were for hour-glass stomach. Among 154 operations for hour-glass stomach which he studied, 128 were in females and 26 in males. The chief **cause** of acquired hour-glass contraction is preceding *gastric ulcer*, but some cases are due to *cancer*, usually to that form which has developed as a consequence of benign ulceration; others are caused by pressure of neighbouring organs, as corset· liver; Rasmussen, according to Schomerus, thought that hour-glass stomach might be caused by *pressure of the left costal border;* some cases are caused by *perigastric adhesions;* and a few are produced by the *ingestion of corrosive liquids*, as in a case recorded by Klein, in which operation was done by Schnitzler. Other cases of hour-glass stomach, due to the ingestion of acids, have been recorded by Carle, Gersuny, Hacker, and Körte. *Syphilitic ulceration* is a rare cause (Guillemot). Langenbuch recorded a case accompanied by *tuberculous ulceration* in both pouches; but the ætiological relation of the ulcers was doubtful.

Clinical Pathology.—The constriction is usually single, situated somewhat nearer the pyloric than the cardiac orifice, and the greater curvature is more often drawn up toward the lesser, than the reverse. But while these are the usual characteristics, a great variety of deformities has been encountered. In the cases studied by Schomerus the constriction was near the pylorus in 51, midway between the orifices in 34, and near the cardia in only 13 patients.

When the pyloric pouch is large there are two dangers—the

first and more common is that at operation the cardiac pouch may be entirely overlooked, and a gastro-enterostomy done with the pyloric portion, without improving the patient's condition. This error, according to Lieblein and Hilgenreiner, has been made by Bier, Czerny, Küster, Hartmann, and others. All the known cases have been attended by a fatal result. The other danger is that an unusually large pyloric pouch may be the seat of *volvulus*, as in cases recorded by Langerhans, Doyen, and others, the greater curvature ascending toward the left, and adding the factor of strangu-

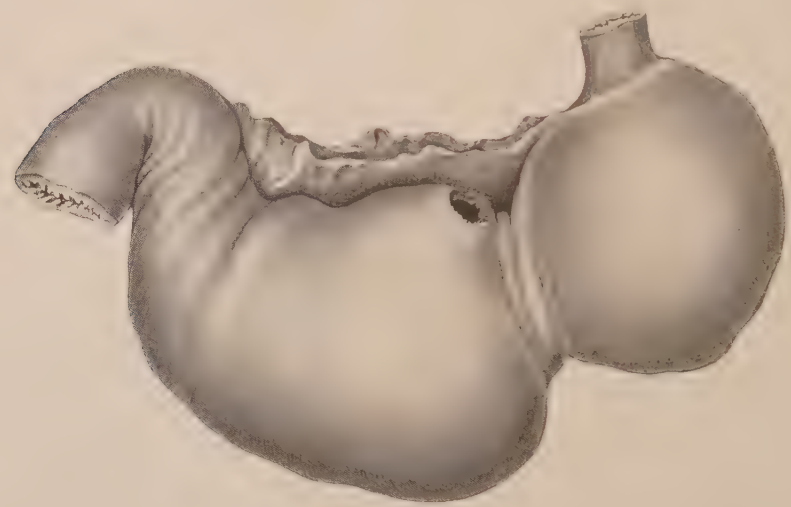

Fig. 23.—Hour-Glass Stomach from Carcinomatous "Saddle" Ulcer on Lesser Curvature with Perforation. (*Half Natural Size.*)

lation to the pre-existent obstruction. Volvulus of a large cardiac pouch does not appear to have been observed.

The frequency with which pyloric stenosis complicates hour-glass stomach has been much emphasized by Robson and Moynihan. The stenosis in both situations may be due to ulcer, or one may be caused by perigastric adhesions. These adhesions may act as a bridle, passing across the stomach from one curvature to the other, or the stomach may itself become adherent to the neighbouring organs or to the anterior abdominal wall. In one case

of trifid stomach, recorded by Robson and Moynihan, both constrictions were due to ulceration; in their second patient one constriction was caused by ulcer, the other by adhesions. Dilatation of the duodenum should not be mistaken for hour-glass stomach. Christian has recorded an interesting case in which such an error was made.

A saddle ulcer on the lesser curvature is a frequent cause of

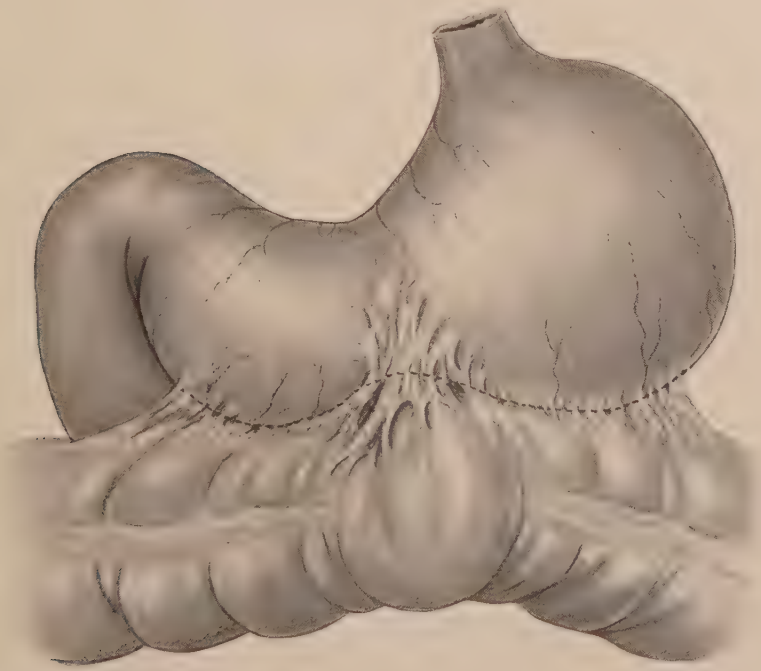

Fig. 24.—Hour-Glass Stomach from Perigastric Adhesions. (*Half Natural Size.*)

hour-glass stomach. In the case reported by Astley Ashhurst, this ulcer showed beginning carcinomatous change. It puckered up the anterior and posterior gastric walls so as to draw the greater curvature up toward the lesser, although it was near this that the ulcer had its origin (Fig. 23). In one patient at the German Hospital the contraction was formed by extensive perigastric adhesions (Fig. 24), while in three others the cause was cicatrization

of gastric ulcers. In one of these latter patients the lesion was thought at operation to be malignant; but as the patient remains in good health more than four years after the operation (gastro-gastrostomy and Finney's pyloroplasty) it is evident that the clinical diagnosis was erroneous.

The **symptoms** of hour-glass stomach are rarely distinguishable from those due to pyloric obstruction caused by ulcer. If the constriction is close to the cardia, the clinical picture simulates obstruction of this orifice. In most of the recorded cases the condition has been found at autopsy, or has been met with unexpectedly at an operation for the relief of long-standing gastric symptoms usually thought to have been caused by ulceration at the pylorus.

Hour-glass constriction is one of the latest results of gastric ulceration. Frequently no history of acute ulceration can be discovered; and it is almost always certain that the condition when met with at operation has existed for many years.

By **physical examination** it is sometimes possible to make a positive diagnosis before opening the abdomen. Moynihan in his first six cases made a correct diagnosis only once before operation; among his next nine patients, however, he made the diagnosis in seven with reasonable certainty before operation. The detection of hour-glass contraction by physical examination depends largely upon the use of the stomach tube. On filling the stomach with liquid through the tube, Eiselsberg noticed that a prominence appeared first in the left hypochondrium, and that a few seconds later this swelling subsided, and a second, further to the right, made its appearance. The passage of fluid from one compartment to the other may sometimes be detected as a gurgling sound. The stethoscope is useful for this purpose, but care should be taken not to mistake the normal deglutition sounds or the pyloric sound for the gurgle due to the passage of liquid through an abnormal constriction. Moynihan, after outlining the empty stomach, gives a Seidlitz powder in two portions; the upper pouch will become distended with carbon dioxide some seconds before the lower. In thin persons the cautious distention of the stomach with air by

means of a hand-bulb may render the bi-loculated stomach appreciable to percussion and palpation, or even to inspection. We have already (p. 59) expressed our preference for this method over distention by means of a Seidlitz powder. When after a measured quantity of liquid has been poured into the stomach a large portion of it cannot be recovered, it may be assumed that the lost portion has passed into the pyloric pouch (Wölfler's first sign). When, during lavage, the water has all returned clear, and there then comes a gush of cloudy fluid mixed with gastric contents, it has been assumed by Wölfler (the test is known as his second sign) that the clear fluid comes from the cardiac and the cloudy from the pyloric pouch. Under similar circumstances, if it be impossible to recover liquid from the stomach even when splashing may be detected in it, it may be assumed that the fluid and air are contained in the pyloric pouch, where the stomach tube cannot reach. This, which is spoken of as "paradoxical dilatation," is known as Jaworski's sign.

If all these signs were present in any one case it might be safe to conclude that hour-glass constriction of the stomach existed; but as each one may exceptionally be observed in other conditions, notably in marked gastric dilatation, the assertion before operation in these cases that hour-glass stomach exists is in many instances a happy guess.

A more satisfactory outline of the stomach may be obtained by means of the X-ray, applied after the ingestion of bismuth (see p. 62).

Treatment.—When surgical treatment is undertaken for this condition a choice of operation has to be made among the following: (1) Digital divulsion of the constricted orifice by means of gastrotomy; (2) Gastroplasty or Gastro-anastomosis; (3) Gastro-gastrostomy; (4) Gastro-jejunostomy; and (5) Partial Gastrectomy.

The statistics of these various procedures have recently been investigated by Schomerus. Digital **divulsion** alone seems to have been employed in only one reported case, by Moynihan, who adopted this method under the impression that he was dealing with an inoperable malignant growth. The patient made a satis-

factory recovery, was relieved of her gastric symptoms, the tumor disappeared, and she was still in good health more than two years later. Blake employed divulsion in a patient whose stomach presented a tight stricture close to the cardiac orifice, but as he also did a gastro-jejunostomy, in the pyloric pouch, some of the benefit derived from the intervention may have been due to the latter procedure. In spite of the successful termination in these cases, divulsion is not now an accepted form of treatment, except in rare instances where the constriction is so near the cardia as to be inaccessible from without the stomach. As in the case of pyloric obstruction, divulsion may be regarded as dangerous, uncertain, and in every way less satisfactory than the other forms of treatment to be described.

Gastroplasty,* analogous to pyloroplasty, is said to have been performed first by Bardeleben in 1889; this operation was attended by a fatal result; but Krukenberg in 1892 employed it successfully, as did Doyen and other surgeons soon afterwards. Gastroplasty is limited in its application to stomachs where the constriction is benign, unattended by induration or active ulceration, and where the pylorus is not itself strictured. The employment of pyloroplasty as well as gastroplasty would only be complicating one not very satisfactory operation by another still less promising. Schloffer in one case complicated by pyloric stenosis sucessfully combined gastroplasty with anterior ante-colic gastro jejunostomy in the pyloric pouch. A modification of gastroplasty, analogous to Finney's pyloroplasty, was introduced by Kammerer, and has been successfully employed by him and by other surgeons. It may be conveniently designated Gastro-anastomosis. Büdinger has employed, unsuccessfully, a flap method of gastroplasty.

Each method may no doubt be suitable in certain cases, but

* Under the name of *gastroplasty* Nicoladoni suggested the substitution of the transverse colon for the stomach after a circular resection of the latter. Although commended by Kocher, it does not appear to have been employed, and is mentioned here only to avoid confusion of terms. The same term, gastroplasty, is used by Jedlicka to describe an operation consisting in resection of gastric ulcers, with restoration of the gastric wall by the sliding flap method commonly adopted in plastic surgery.

as a general rule gastroplasty is less successful than one of the methods presently to be described. Schomerus has collected 47 cases of gastroplasty for hour-glass stomach, wth 5 deaths (10.6 per cent. mortality); and 5 cases in which pyloroplasty was also done (20 per cent. mortality); as well as 4 cases in which gastro-jejunostomy was performed, with a mortality of 25 per cent. Although the operative mortality (10.6 per cent.) of simple gastroplasty is thus seen to be moderate (some of the deaths cannot be attributed to the operation), the remote results have been disappointing. Paterson found that "in at least 25 per cent. of the patients who have recovered, either no relief has followed, or relapse has occurred subsequently."

Gastro-gastrostomy, which, under the name of gastro-anastomosis, was first employed, and successfully, by Wölfler in 1894, is even more limited in its application than is gastroplasty. Unless the two pouches of the stomach can be approximated without tension, the operation is not only difficult of execution, but may be attended by a fatal result from giving way of the sutures. It is therefore contra-indicated when the cardiac pouch is small, when the scar is wide-spreading, or when many adhesions are present. In inoperable cases of malignant disease it is possible that some temporary relief of symptoms might be thus obtained, but usually in these, as in benign affections, better results will follow gastro-jejunostomy. The main indication, we think, for gastro-gastrostomy is in the treatment of an hour-glass constriction with large pyloric pouch in the presence of pyloric obstruction, when the pyloric pouch may be successfully drained by gastro-jejunostomy. If pyloric stenosis does not exist, gastro-jejunostomy in the cardiac pouch is to be preferred; though if the symptoms are due to dilatation of the cardiac pouch without marked stenosis of the lumen between this and the pyloric pouch, gastro-gastrostomy may prove effectual, as in Wölfler's patient. Watson in 1896 employed a modification of gastro-gastrostomy, which not only complicated the operation, but in no way improved its results. Schomerus collected 19 operations by gastro-gastrostomy, with 3 deaths (16 per cent. mortality), as well as 2 successful cases in which gastro-

enterostomy was also done. Paterson concludes that "at least 30 per cent. of the patients on whom this operation has been performed have either obtained no relief or have relapsed."

Gastro-jejunostomy has been employed, according to Schomerus, 52 times for hour-glass stomach. Among these patients, 6 died (11.5 per cent. mortality). Recurrences were extremely rare. Paterson found only 2 recurrences among more than 30 patients whom he traced; and in one of these the return of symptoms was "clearly due to the coexistence of pyloric stenosis." The anastomosis should of course be made with the cardiac pouch; and as the existence of this pouch, and consequently the presence of hour-glass stomach, has been overlooked at operation by some very competent surgeons, it is well to bear in mind Moynihan's advice, always to make a point of examining the whole stomach from œsophagus to duodenum, before undertaking any operation on it whatever. If pyloric stenosis coexists with hour-glass constriction, simple gastro-jejunostomy will not effect a cure, unless the pyloric pouch be very small indeed. Hacker was the first (1895) to consider the treatment of double gastric stenosis, and the principles which he then laid down guide the surgeon still. His proposals were: (1) To combine gastroplasty, resection, or gastro-gastrostomy with pyloroplasty, pylorectomy, or gastro-jejunostomy in the pyloric pouch; or (2) that gastro-gastrostomy should be combined in one opening with gastro-jejunostomy, so that, in other words, both gastric pouches should drain through the one gastro-intestinal anastomosis. Mikulicz is said to have adopted this method in connection with a gastroplasty. Finally, v. Hacker proposed a double gastro-jejunostomy, uniting each gastric pouch separately with a loop of the jejunum. This method was also advocated (1896) by Wier and Foote, by whose names it is generally known in this country. Clément, of Fribourg, did an anterior gastro-jejunostomy "in-Y" with double lateral anastomosis to the gastric pouches. Monprofit proposed a double gastro-jejunostomy "in-Y," after Roux's method by implantation, which appears to us a more complicated operation and one no more likely to be successful than that employed by Clément. Of these various opera-

tive combinations, it appears to us that these are to be preferred: (1) With small cardiac pouch, gastro-gastrostomy or gastroplasty with gastro-jejunostomy in the pyloric pouch; (2) with large cardiac pouch, Finney's pyloroplasty with gastro-jejunostomy in the cardiac pouch; (3) with very small pyloric pouch either (*a*) gastro-jejunostomy in the cardiac pouch alone, (*b*) gastro-jejunostomy in the cardiac pouch combined with gastro-gastrostomy or gastroplasty, or (*c*) lateral gastro-duodenostomy, that is, an anastomosis between the cardiac pouch and the duodenum, as successfully practised in one such case by Schnitzler. In our own hands, posterior gastro-jejunostomy combined with gastro-gastrostomy has effected a cure in two patients; a third was successfully treated by gastroplasty and posterior gastro-jejunostomy; while the fourth patient, as already mentioned, remains well more than four years after the performance of gastro-gastrostomy and Finney's pyloroplasty. If there were malignant disease, our preference would naturally be for excision, where practicable. In the patient with *trifid stomach* operated on by Moynihan, gastro-gastrostomy was employed to unite the cardiac and median pouches, the constriction between the latter and the pyloric pouch was dilated by the fingers, and the pyloric pouch was drained by gastro-jejunostomy. In Paterson's patient, gastroplasty was employed to connect the pouches, and gastro-jejunostomy was done in the pyloric pouch, which was the largest of the three. His patient was in good health two years later.

Gastrectomy for hour-glass stomach, when the obstruction is benign, appears to be unnecessarily severe. Schomerus collected 8 such operations, with only one death. In six cases (Bergmann, Hahn, Körte, Krause, Kümmell, Zeller) circular gastrorrhaphy was done after resection, the lumen of the stomach thus being restored without resort to gastro-jejunostomy. In Hedlund's patient the cardiac pouch was closed by sutures, and then the pylorus was united with the posterior wall of the cardiac portion of the stomach by Kocher's method of implantation. Büdinger, after closing each portion of the stomach separately, did a posterior retro-colic gastro-jejunostomy. The only fatal result was in Zeller's patient (1893), and was due to the perforation of another ulcer.

Schomerus collected 10 operations for hour-glass stomach due to **malignant disease.** The results in 9 may be seen in the following table:

Operator.	Operation.	Immediate Result.	Ultimate Result.
Eiselsberg	Gastro-jejunostomy.	Recovered.	....
Kocher	"	Died in 4 days.	....
Mikulicz	"	Recovered.	Died in 3½ months.
Schmitt	"	Recovered.	Well after 6½ months
Moynihan	Excision of ulcer with Gastroplasty and Pyloroplasty.	Died in 4 days.	....
Moynihan	Jejunostomy.	Recovered.	Died in 1 month.
Robson	Gastrectomy.	Recovered.	Well after 2 years.
Robson	"	Recovered.	Well after 1 year.
Robson	"	Died in 11 days.	....

OPERATIONS FOR HOUR-GLASS STOMACH.

(After Schomerus.)

Operation.	Cases.	Recovered.	Died.	Mortality Per Cent.
Resection	8	7	1	12.5
Digital divulsion	1	1	0	00.0
Gastroplasty	47	42	5	10.6
Gastroplasty and pyloroplasty	5	4	1	20.0
Gastroplasty and gastro-jejunostomy	4	3	1	25.0
Gastro-gastrostomy	19	16	3	16.0
Gastro-gastrostomy and gastro-jejunostomy	2	2	0	00.0
Gastro-jejunostomy	52	46	6	11.5
	138	121	17	12.3

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Gastric Diverticula.—Distinct diverticula of the stomach are very rare. They are divided by systematic writers into those due to pressure, and those due to traction. Every case of dilated stomach from stenosis is really an example of a pressure diverticulum, the deformity in cases of hour-glass stomach sometimes assuming a form more characteristically pouched. Of the distinct diverticula, the form due to traction is less unusual, and is produced by adhesions between the stomach and neighbouring structures, especially the pancreas, the liver, and the diaphragm in the region of the cardia. Examples of *pressure diverticula* have been recorded by Schulten, Kleine, Grassberger, Thorel, and Hirsch. Kolaczek, Tilger, Heubel, Hansemann, and Silbermark, among others, have described *gastric diverticula due to traction.* Zahn, from whose article many of these references are taken, observed a gastric diverticulum in which both pressure and traction were probably causative factors. Horrocks has recorded a case which he regards as *congenital.*

Almost invariably the primary *cause* is gastric ulcer, though a few examples are recorded from carcinoma. If the pouch is so situated and of such conformation as to favour the lodgement of food, it may when thus distended simulate a malignant tumor. Diagnosis before operation or autopsy is almost impossible. Treatment must be adapted to suit the condition as found. Lieblein and Hilgenreiner think that in case the diverticulum is small, and not prone to collect gastric contents, a gastro-enterostomy will suffice to effect a cure, by relieving pressure and allowing the distended pouch to contract. Of course gastrolysis must in most cases be an integral part of the operation. In other cases excision of the pouch will be required. This may prove a difficult and dangerous operation. Gastro-gastrostomy might in some cases be preferable.

Only two patients appear to have been subjected to *operation.* Kolaczek, in a patient in whom there was present a mass in the epigastric region, adherent to the abdominal wall, made a diagnosis of ulcerating leiomyoma of the stomach. This diagnosis was based on the long duration of the tumor, which excluded malignancy; and on the fact that he considered leiomyoma the least

rare form of benign tumor. He excised the mass, which proved to be a diverticulum of the stomach involving the pancreas. The patient recovered and was reported well six months later. The other operation, by Mosetig-Moorhof, was reported by Silbermark. The diagnosis in this case was osteomyelitis or malignant growth of the left costal margin. Extirpation was undertaken, and the gastric pouch was unwittingly opened, without, however, invading the general peritoneal cavity, which was shut off by adhesions. The tract was found to be lined with mucous membrane, and a sound passed into the stomach through the nose came out through the abdominal wound. A tube was passed into the duodenal end of the stomach from the wound, and the gastric opening was tamponaded. One week later the abdomen was opened in the median line, the stomach was dissected free from the anterior abdominal wall, the edges of the ulcerated area, in which the diverticulum had formed, were freshened, and the stomach was closed by sutures, reinforced by an omental graft. The patient recovered, and was reported in good health one month later.

As Kolaczek says, when a tumor exists in a female, with symptoms of gastralgia and a manifestly chronic course, the tumor being hard, painful, and scarcely at all increasing in size; being also adherent to the abdominal wall in the left epigastrium, one should first of all think of the possibility of a traction diverticulum following gastric ulcer.

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CHAPTER VIII.

BENIGN DISEASES OF THE DUODENUM.

DUODENAL ULCER.

Duodenal ulcer resembles ulcer of the stomach in so many respects that much of what has been said of the latter will apply equally to the former. It is therefore our purpose here merely to indicate the chief differences in the incidence, symptoms, clinical course, and treatment, which render a separate discussion of these conditions necessary.

All ulcers on the duodenal side of the pyloric vein, which runs upward from the greater curvature of the stomach, are classed by Mayo as duodenal. Most ulcers, therefore, formerly classed as *pyloric*, are thus regarded as *duodenal*.

In regard to the **causes** of duodenal ulcer, no more is known than of those of ulcer of the stomach. Formerly considered a much rarer disease, modern surgery has caused it to be acknowledged that it is encountered almost as frequently as gastric ulcer; indeed W. J. Mayo reports that among 193 cases, 60 were gastric, 119 duodenal, and 14 had independent ulcers of the stomach and duodenum. Duodenal ulcer, like ulcer of the stomach, is more frequent in Great Britain than on the continent of Europe, and probably is less usual in Europe even than in this country, which nevertheless probably furnishes fewer cases absolutely and relatively than does England. Gandy and likewise Dieulafoy hold that duodenal ulcer, like gastric ulcer, is in most instances of toxæmic origin. Some authors hold that trauma from the chyme as it is squirted through the pylorus is a predisposing cause of ulcer of the duodenum; and it is true that the usual site of duodenal ulcer lends support to this theory. The influence of extensive

burns is also well known, but not one of the theories which attempt to explain this severe complication is altogether satisfactory.

Duodenal ulcer seems to have a predilection for male adults, especially for those between thirty and fifty years of age, whereas gastric ulcer is most characteristic of young women under thirty years of age. Notable exceptions to this rule, however, are occasionally encountered. Genrich has recorded a perforation of a duodenal ulcer in an infant 21 hours old; and Torday reported a duodenal ulcer found at autopsy in an infant of nine months. Hahn, according to Lieblein and Hilgenreiner, found at autopsy on an infant two days old a duodenal ulcer which had caused death from hemorrhage. Cases such as these, in infants, are no doubt of toxæmic origin. Among Collin's 273 patients, 16 (6.22 per cent.) were less than one year old. The following tables, compiled from various sources, give the statistics bearing on these points:

AGE INCIDENCE OF DUODENAL ULCER.

(Combined figures of Krauss, Chvostek, Oppenheimer, and Collin.)

Age.	No. of Cases.	Age.	No. of Cases.
Under 10 years	40	50 to 60 years	72
10 to 20 "	26	60 to 70 "	30
20 to 30 "	60	70 to 80 "	21
30 to 40 "	88	80 to 90 "	3
40 to 50 "	69	90 to 100 "	3

ANALYSIS AS TO SEX.

Author.	Cases.	Male.	Female.	Ratio.
Alloncle	44	42	2	21:1
Chvostek	61	44	17	3:1
Collin	257	205	52	4:1
Grünfeld	4	3	1	3:1
Krannhals	6	3	3	1:1
Krauss	64	58	6	10:1
Lebert	39	31	8	4:1
Oppenheimer	79	56	23	2:1
Trier	54	45	9	5:1
Mayo	272	209	63	3⅓:1
Robson	66	57	9	6:1

Duodenal ulcer is more often single than gastric ulcer, although it is more usual for it to invade the pylorus, and thus become partly gastric, than for it to exist isolatedly in the duodenum. In the immense majority of cases the ulcer occupies the region of the duodenum above the entry of the bile-ducts. The descending

portion of the duodenum is very seldom affected, and the transverse is still more rarely the seat of ulceration. By combining the statistics of Perry and Shaw, of Oppenheimer and of Collin, we find that duodenal ulcer occurred in the first portion in 434 cases (92 per cent.); in the descending portion in 28 cases (6 per cent.); and in the third portion in 12 cases (2 per cent.). Statistics as to the location of the ulcer on the circumference of the duodenum vary; our own impression, from experience at operation and in the dissecting room, is that it is more frequently seen on the upper wall of the first portion of the duodenum than elsewhere. Collin found it 71 times on the anterior wall, 45 times on the posterior, 10 times on the upper, and only once on the lower wall of the duodenum.

Symptoms.—While in general characteristics the symptoms of ulcer of the duodenum bear a close resemblance to those of gastric ulcer, there are certain factors sufficiently distinctive, if they be present, to render possible a positive diagnosis of the site of the lesion.

Duodenal ulcer is even more apt to be *latent* than is ulcer of the stomach. Perforation is quite usually the first symptom calling for medical advice. Among 151 cases analyzed by Perry and Shaw the first symptom in no less than 91 was the hemorrhage or perforation from which the patient died. F. Brunner found a history of previous symptoms of duodenal ulcer could be obtained in only 56 per cent. of the patients with perforation whose cases he analyzed. Weir, however, found the previous history positive on this point in 25 (73 per cent.) of 34 cases of duodenal perforation.

Pain in duodenal ulcer typically does not occur until two or three hours after the ingestion of food. Indeed many patients will entirely deny the existence of pain, and only on close questioning will admit that they feel more comfortable when the stomach has some food in it, then they do soon before taking their meals. They frequently acknowledge that they are averse to letting their stomachs remain empty more than two or three hours at a time. They will not sleep soundly the night through unless they have eaten a little late supper just before retiring; or they will be in the habit of taking a cracker

and a glass of milk during the night when they wake up in the small hours. All these are manifestations of what Mayo Robson has graphically called the "hunger pain" of duodenal ulcer. But it is to be noted that patients are rarely aware that it is the discomfort which impels them to keep their stomach constantly occupied. They rather think that the eating at shorter intervals than other people is an idiosyncrasy not based on any pathological cause. It is quite generally acknowledged that the reason the presence of food in the stomach keeps in abeyance the pain, is because thus the acid gastric secretion is neutralized before passing the pylorus, and thus irritation of the ulcer is prevented. Pain is less often *referred* than in ulcer of the stomach. But it must be confessed that gastric ulcer so often exists along with an ulcer in the duodenum, that these distinctive signs are often lacking.

Vomiting is unusual in duodenal ulcer, unless stenosis of the pylorus is present. *Hæmatemesis* is equally rare. *Melæna*, on the other hand, is as usual in ulcer of the duodenum as is hæmatemesis in gastric ulcer. The quantity of blood in the bowel movements, however, is frequently very small, and often escapes the attention of the patient altogether. The tests for *occult blood* are then of great aid in reaching a diagnosis.

Tenderness in duodenal ulcer is almost invariably close to the right costal border, and characteristically is not confined to one spot, but extends through the descending portion of the duodenum.

Jaundice is a rare sign, and is generally thought to indicate that the papilla of Vater is invaded by the ulcer, though it may be due merely to concurrent catarrhal duodenitis.

Perforation is much more frequent than in gastric ulcer. About fifteen per cent. of patients with ulcer of the stomach die from perforation, whereas of those with duodenal ulcer probably one-fourth will develope this complication. Laspeyres gives the following statistics in regard to the frequency of perforation in ulcer of the duodenum: Chvostek found it to occur in 42 per cent. of patients, Collin in 69 per cent., and Oppenheimer in 48 per cent. of patients. Among 272 operations for duodenal ulcer Mayo records 66 for perforation (16 acute, 13 subacute, and 37 chronic perfora-

tions). According to F. Brunner, perforation is more frequent in America than elsewhere, being next most frequent in France and Switzerland. This frequency he attributes to the excessive use of alcoholic stimulants. From the statistics he collected he found perforation of duodenal ulcer occurred ten times in the male to once in the female; whereas perforation of gastric ulcer occurred only once in the male to four times in the female.

The perforation is much most frequent in the first portion of the duodenum, and usually is on its anterior wall.

SITE OF PERFORATION OF THE DUODENUM.

Author.	First.	Descending.	Transverse.	Total Cases.
Brunner	62	7	3	72
Oppenheimer	34	3	0	37
Perry and Shaw	48	2	1	51
Total	144	12	4	160
Per cent	90	7.5	2.5	100

SITE OF PERFORATION IN FIRST PART OF DUODENUM.

(After Laspeyres.)

Author.	Anterior Wall.	Superior Wall.	Posterior.	Inferior.	Total.
Oppenheimer	11	1	3	0	15
Perry and Shaw	19	0	6	0	25
Collin	71	10	45	1	127
Total	101	11	54	1	167
Per cent	60.5	6.5	32	1	100

Among the 62 perforated ulcers in the first part of the duodenum recorded by Brunner, 9 were on the posterior wall, 38 were on the anterior and upper wall, while in 15 cases the site of the perforation was not mentioned.

The rarity of perforation on the lower wall, as well as on other retro-peritoneal portions of the duodenum, is no doubt due to the protection afforded by the pancreas and other retro-peritoneal structures. Were the duodenum provided with a mesentery, perforations of its lower wall might occur more frequently, but even then perforations would still be more apt to occur at the point of poorest blood supply. Perforations into neighbouring organs have seldom been observed. Perforation of the duodenum into the

stomach appears to be unknown; that of the stomach into the duodenum, though extremely rare, has nevertheless been recorded in a few instances. Subphrenic abscess was caused by duodenal perforation in 6 out of 58 cases of the former condition collected by Nowak.

In regard to symptomatology of perforation of duodenal ulcer, little need be added to what has already been said (at p. 86) in connection with gastric perforations. The great frequency with which duodenal perforation simulates appendicitis should be borne in mind. Moynihan in 1901 collected 49 operations for perforation of the duodenum, in 18 of which the diagnosis had been appendicitis. If at an operation undertaken for appendicitis, especially in a male adult, no lesion of the appendix be found sufficient to account for the state of the peritoneal cavity, the surgeon will do well immediately to examine the region of the pylorus. In very many cases his search for perforation will be rewarded. The presence of gas in the peritoneal cavity is a sign usually indicative of perforation rather high in the intestinal tube.

Prognosis.—There can be no question that ulcer of the duodenum is a graver disease than is gastric ulcer; its greater liability to fatal hemorrhage and to perforation make a sudden death probable in about half the cases, unless some treatment can be applied which will not only relieve the symptoms, but entirely cure the disease. Medical treatment is of course available, and if adopted as soon as the disease is suspected may in some cases allow the ulcer to heal. If this happy event occurs, it is not probable that further trouble will be caused by obstruction from the cicatrix. Yet in rare instances hourglass duodenum has developed; and in not a few patients it seems likely that persistence or recurrence of indigestion after so called medical cure, may be due to cicatricial contraction.

Surgical treatment offers for duodenal ulcer no less sure a cure than for ulcer of the stomach, and the mortality of operation for non-perforated cases is no higher. Robson, in an excellent review of the subject, reports his own series of 66 operations for unperforated duodenal ulcer, with no deaths attributable to the opera-

tion. Mayo reports an operative mortality of 2.8 per cent. among 119 cases treated in 1906 and 1907. Robson is of the opinion that the symptoms of duodenal ulcer have only lately become well recognized, and thinks that therefore the proportion of cases which perforate, as usually given, is too high, because in these statistics only the severest cases of duodenal ulcer are included. Thus he says that in his own experience perforation has occurred in only 10 per cent. of cases; and he adds, what is a consideration of the utmost consequence, that he is convinced he has by timely resort to gastro-jejunostomy effectually prevented perforation from occurring.

The prognosis when perforation has actually occurred, is much less favourable. Mayo reports 3 deaths among 16 acute perforations, no deaths among 13 subacute, and 1 death among 37 chronic perforations of the duodenum. Although Robson speaks hopefully of the mortality from this cause being reduced to 5 or 10 per cent. for those patients operated on within twelve hours of perforation, it scarcely seems likely that such excellent results can be obtained in the near future. The actual figures collected by Robson, comprising 155 operations from various sources, gave a total mortality of 66 per cent., as may be seen in the following table:

OPERATIONS FOR DUODENAL PERFORATION.

Time.	Cases.	Recovered.	Died.	Mortality per cent.
Under 24 hours	61	38	23	37.7
Over 24 hours	63	11	52	82.5
Not stated	31	3	28	90.3
Total	155	52	103	66.66

Treatment.—Surgical treatment for duodenal ulcer was at first confined solely to the attempted repair of perforations; and it is not until within the last five or six years that the cure of the ulcer has been undertaken, by resort to gastro-enterostomy or other similar operation. According to Weir, it was Sidney Jones in 1888, who first operated on a patient with a duodenal perforation. No diagnosis other than peritonitis was made, and the perforation was discovered only at the autopsy. Four similar operations, with fatal results, followed this first resort to surgery, and it remained for Gould to find and to suture the ulcer, although

his patient survived only six hours. Five other fatal operations followed Gould's; but finally a patient operated on by Dean, in 1894, recovered from the operation, but died two months later from intestinal obstruction. The patient of Landerer and Glucksmann (1896) survived six months, and then died of another perforation of the duodenum; but Dunn's patient, operated on in this same year, is credited with permanent recovery.

As a prophylactic against perforation, and as a cure for the ulceration, *gastro-enterostomy* is the most successful form of surgical treatment. Among the earliest surgeons to resort to this operation in non-perforated duodenal ulcer, according to Pagenstecher, was Codivilla; his patient recovered and was in good health five years later; Berg and Roux are also mentioned by Weir as among the first to operate for non-perforated ulcer of the duodenum. Excision of the ulcer, with gastro-duodenostomy, can only rarely be advisable. We have never seen a case in which posterior gastro-jejunostomy did not seem preferable. Even if the pylorus is patent, it is seldom necessary to occlude it by ligature or otherwise. If modern gastro-jejunostomy (*i. e.*, the posterior operation without a loop) be adopted, the vicious circle and regurgitant vomiting will be found to have become things of the past.

When perforation has occurred, operation at the earliest possible moment is demanded. Shock is no contraindication to operation. The shock is due largely to the perforation and to the gas in the peritoneal cavity; and the sooner the surgeon opens the peritoneum, allows the gas to escape, and then closes the hole in the duodenum by which it first made its exit, the better it will be for his patient. A large sand pillow under the lumbar spine will aid materially in bringing the duodenum up into the operative field; and in case this proves particularly difficult, it will be well to "mobilize" the duodenum. The perforation is to be sutured; Lembert sutures, preferably of the mattress type, are the best; and if the sutures do not hold well, a tag of omentum should be stitched over the sutured area. Unless there is a history of indigestion of long standing, and unless the peritoneum is only slightly soiled and the patient in very good condition, it is not usually recommended to perform

gastro-jejunostomy at the same sitting. In cases where operation is done in a few hours after perforation, we think gastro-jejunostomy may properly be done also; but if peritonitis is extensive, it had best be postponed. After a few weeks or a month this operation may be done with the utmost safety, and with every prospect of affording the patient a permanent cure. Especially true is this in cases of subacute perforations of the stomach and duodenum. The first and most important thing in such cases is to arrest and to cure the peritonitis; and only when the peritoneum is healthy should an operation such as gastro-jejunostomy be employed.

Robson has called attention to the importance of treating pancreatitis when present as a complication of duodenal ulcer. Reference has already been made to the occasional presence of jaundice in patients with ulcer of the duodenum; and when this is a recurrent or a persistent symptom, and especially if fever and other evidences of infection develope, the presence of cholangitis and pancreatitis should be suspected. Under such circumstances we have resorted to cholecystotomy with drainage, with the most gratifying results; and where very prolonged or permanent drainage is indicated, it will be proper to do a cholecysto-enterostomy—an operation which has been practised with success under such conditions by Mayo Robson.

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MISCELLANEOUS AFFECTIONS OF THE DUODENUM.

Congenital Imperforation of the Duodenum, examples of which rare condition have been recorded by Cleemann, Trump, Stewart, and others, could be differentiated during life from imperforation of the pylorus only if the occlusion were below the papilla of Vater, thus allowing bile to be regurgitated into the stomach. Should a diagnosis be made, gastro-jejunostomy should be performed; but as malformations of the bile ducts and liver sometimes co-exist, the prognosis is exceptionally gloomy. In the cases just referred to, the occlusion was below the papilla of Vater; in cases reported by Collum, Emerson, Hobson, and others, it was situated above the entrance of the bile ducts. Shaw and Baldauf have recorded a case of *congenital stricture* of the duodenum in a girl aged 13 days; the lumen was found at autopsy to be permeable only to fluids under pressure. They quote Kuliga as having collected 185 cases of congenital occlusion of the intestines; of these, 46 (25 per cent.) were of the duodenum, 94 of the jejunum, and 45 of the colon and rectum. Perry and Shaw refer to 7 cases of *congenital stenosis* of the duodenum.

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Strictures of the Duodenum sometimes result from cicatrization of ulcers. Affections of the biliary tract (calculi) or pancreas (pancreatitis or carcinoma) are more frequent causes. Albu collected 43 cases of stenosis of the duodenum, at least 15 of which were due to affections of the pancreas. The operation which has

been adopted in cases of duodenal stricture by Bazy, Mackenzie and others, is named *duodenoplasty*, and consists in longitudinal incision and transverse suture of the constricted portion of bowel. If the adhesions are few or easily separated, and the duodenal wall not too thick or friable, this is a better procedure than gastro-enterostomy in cases of stenosis due to changes in the intestinal wall, and is the only rational operation in simple strictures close below the papilla of Vater. If the stricture were entirely retro-peritoneal in position, as in the transverse duodenum, a duodeno-jejunostomy on the proximal side of the obstruction might be possible.

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Chronic Dilatation of the Duodenum is occasionally seen. It is usually due to an obstruction either at the duodeno-jejunal flexure or to pressure from the superior mesenteric artery. The duodenal sphincter described by Ochsner may be an unrecognized cause. Finney has called special attention to chronic dilatation of the duodenum, and in discussing his paper Prof. Barker suggested duodeno-jejunostomy as a remedy. This operation has been employed successfully by Stavely. We have observed this condition in a number of cases of gastric and biliary affections, and have little doubt that many patients with symptoms of pyloric obstruction who are found to have a patent pylorus are suffering from dilatation of the duodenum. Christian has recorded a case where chronic dilatation of the duodenum was mistaken for hour-glass stomach.

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Hour-glass Duodenum usually is a late result of stricture, following ulceration. The stricture is usually above the bile pa-

pilla, frequently close to the pylorus. Mackenzie has lately published details of several cases of this malformation, and suggests a number of operations for its relief. He has himself employed gastro-jejunostomy in two patients under his care: cure resulted in the first, which appears to have been a stricture rather than an example of true hour-glass deformity; but the second patient, presenting a well-marked deformity, though much improved by the operation, still had considerable gastric discomfort. Preferable operations are duodenoplasty (Ladevéze, Bazy, Mackenzie); duodeno-duodenostomy (Mayo); or gastro-duodenostomy to the distal pouch of the duodenum. All these procedures are much more readily executed after mobilization of the duodenum. Riegel and Hollscher also are said to have reported cases of hour-glass duodenum.

REFERENCE.

Mackenzie: Jour. Amer. Med. Assoc., 1906, ii, 341.

Diverticula of the Duodenum have been noted by several observers. It was Morgagni who first described the condition. Letulle noted in two cases little pouches in the neighbourhood of the bile papilla, and thought they were to be explained as a congenital anomaly of developement due to the budding out from the duodenum of processes, as in the formation of the liver and pancreas. The patient recorded by Pilcher had a large retro-peritoneal cyst, opened at operation above the ileum and to the left of the ascending colon; the cyst at autopsy was found to be in communication with the lumen of both duodenum and jejunum, being intercalated in the intestinal tract between these structures, and having formed as the result of extensive destruction of the transverse portion of the duodenum from ulceration.

Perry and Shaw classify diverticula of the duodenum as distension and traction pouches. Usually found close to the papilla, as in Letulle's patients, they are next most frequent at the pylorus. They usually produce no symptoms, and are found at autopsies in the aged. The developement of pressure pouches is aided by the presence of the pylorus above and Ochsner's sphincter below.

Traction diverticula are less usual, and are generally due to perigastric adhesions the result of ulcer or cholecystitis. Perry and Shaw mention 14 cases of pressure diverticula, and found at Guy's Hospital records of three patients with traction diverticula. Excision is the best treatment.

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CHAPTER IX.

BENIGN TUMORS OF THE STOMACH AND DUODENUM.

Benign tumors of the stomach and duodenum are rare. As has been seen in the preceding pages, a palpable mass, when not malignant, is almost invariably hyperplastic or inflammatory in origin. The non-malignant neoplasms most frequently encountered in the stomach are myoma, adenoma (including polyp), lipoma, and cysts.

Before proceeding to a detailed account of each variety, it will be well to state in a few words the general characteristics which most of these growths possess in common. Although heretofore found most frequently at autopsy, in patients who as a rule are not known to have suffered from gastric symptoms during life, it is altogether probable that with the increasing number of operations on the upper abdomen, more of these tumors will in the future be found at operation, even if they may not have been correctly diagnosticated before the abdomen was opened.

The patient is usually an adult, probably more often female than male, who has suffered from gastric indigestion for a number of years. Pain of a dragging and tearing character is sometimes a prominent symptom. Vomiting, if it occurs at all, usually arises a half hour or an hour after eating, but is present with no regularity as in gastric ulcer. The vomiting may occur only once or twice during the whole course of the illness, or it may, especially in the case of polypoid growths, recur whenever gastric peristalsis is excited. In very pronounced polypoid conditions of the mucosa, the nausea may be constant. Hæmatemesis is rare, being seen most often in adenomatous tumors, or in myomatous tumors which have penetrated the cavity of the stomach and have become ulcerated. The blood is then usually clotted before being vomited; the vomiting of bright red blood is quite unusual. The tumors in the

course of time are prone to excite perigastritis, and the adhesions both interfere with gastric motility, and cause increased pain. Frequently the tumor, though of fair size, is not palpable because held by adhesions beneath the costal margin, or because perigastritis renders the overlying muscles so rigid that satisfactory palpation is impossible. Large subserous tumors of the stomach with a long pedicle may, on the contrary, be very movable, and occasionally are found even in the hypogastric region. The physical signs of hour-glass stomach may be simulated by submucous growths in the median portion of the stomach.

The long duration of a palpable mass is the chief means by which malignant disease may be excluded. A diagnosis of benign tumor is sometimes made in cases of inflammatory hyperplasia; and Kolaczek, as already mentioned (p. 199), diagnosed leiomyoma in a patient with a gastric diverticulum adherent to the anterior abdominal wall.

Myoma and Fibromyoma. Myoma of the stomach was first observed by Morgagni. Steiner in 1898 collected 58 cases of myoma of the gastro-intestinal canal, 21 of which were situated in the stomach, and only 3 in the duodenum. To these cases of gastric myoma may be added 28 additional cases recorded by: Borrmann, Bouveret, Caminiti, Cappello and Cappello, Cernezzi, Cohn (2 cases), Cutler, Ehrenberg, Goullioud (2 cases), Jean, Kidd, Magnus-Alsleben (5 cases of adeno-myoma), Miodowski, Monro, Moser (3 cases), Noll, Perls and Neelsen, Poirier, Samter, and Yates.

These, with the 21 cases collected by Steiner, make a total of 49 cases of gastric myoma recorded to date, so that it can no longer be regarded as an excessively rare condition. It is probable, moreover, that very small myomata are sometimes overlooked at autopsy. Among 3500 autopsies at Genf, Tilger found 6 nut-sized myomata and fibromyomata of the stomach. Bircher has recently recorded a case of pedunculated *fibroma* of the stomach.

Generally situated along one or the other curvature, they are less unusual close to the pylorus than at the cardia. Arising in the muscular tunics of the stomach wall, they grow either inward

or outward, projecting as a rounded more or less nodular mass, beneath either the mucous membrane or the peritoneal surface of the organ. Being at first attached to the muscular coat by a pedicle, this may become extremely attenuated, as in Cernezzi's case, and finally all connection between the tumor and the muscular tunic from which it sprang may be lost (Virchow), as in the case of the analogous tumors of the uterus. Gastric myomata are almost invariably single, only two cases of multiple myoma being recorded (Laboulbène, Picenti) if we except certain forms of

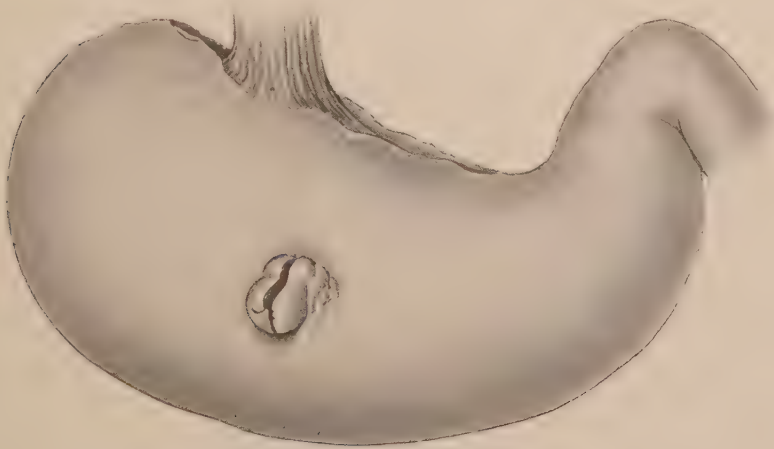

Fig. 25.—Fibroma of Posterior Wall of Stomach. One Half Natural Size. (*From a specimen in the Museum of the German Hospital.*)

polypus which are really more adenomatous or fibromatous in character.

Internal myomata, as those are called which project into the cavity of the stomach, frequently become ulcerated, and give rise to hæmatemesis or melæna. Fatal hemorrhage occurred in cases recorded by Kemke, Miodowski and Niemeyer. These tumors are seldom very large, and often cannot be detected through the abdominal wall. External myomata, on the other hand, sometimes grow to an immense size, the tumor in Erlach's patient weighing 5400 grammes, and reaching in the case of Perls and Neelsen deep

into the pelvis, and weighing 6000 grammes. The gastric origin of such large tumors frequently is not recognized, both on account of their position in the abdomen, and because of secondary attachments which are formed to other structures. Yet adhesions to the anterior abdominal wall are unusual, and free mobility is a frequent characteristic; especially noteworthy is the fact that the uterus can almost always be excluded as the seat of the disease. In 23 of the reported cases the tumor is recorded as being internal, in 21 as being external, and in 1 the growth was still interstitial in character when excised (Poirier) on account of pylorospasm. The age of 25 patients is recorded; 19 were over 40 years of age, and 13 of these were more than 50 years old. Of the 27 patients whose sex is stated, 11 were males and 16 females.

The great majority of gastric myomata are strictly benign, but occasionally they are malignant. There is great confusion among pathologists as to the classification of these malignant varieties. In a great many myomata there have been noted certain areas of œdema, amounting in some instances to myxomatous degeneration. When this condition is pronounced, the term myxomyoma is applied (Kemke). Cysts may be formed thus, or as the result of hemorrhage into the tumor. Certain cases have been reported (Goullioud and Mollard, Goullioud, Brodowski, Hansemann, Cohn) in which gastric myomata, with more or less myxomatous degeneration, have given rise to metastases in the liver, peritoneum, and other structures; and in these metastatic nodules the primary growth was in large part reproduced, the cells being clearly smooth muscle cells, with an admixture of myxomatous, or degenerated cells. In their interpretation of the "degenerated" cells, either in the primary tumor or in the metastases, pathologists are not in accord. They were long regarded as sarcoma cells, and the primary tumor was said to have undergone sarcomatous degeneration. But some writers, following the teaching of Bard of Lyons, and maintaining the theory of the specificity of tumor cells, claim that tumors such as those just described are pure myomata, and that the so-called sarcoma cells are nothing more than immature smooth muscle cells. These authorities (Parrot and Bérard; Devic and Galla-

vardin; Giuliani) name such a tumor Leiomyoma malignum. Steiner, Cernezzi, and others, distinguish between sarcomatous myomata, and myosarcomata; the latter being a malignant tumor *ab initio*, whereas a sarcomatous myoma is one which, though at first benign, finally undergoes malignant degeneration. Of course there is theoretically no reason why the connective tissue cells, present in a fully developed myoma, should not, as described by Steiner (loc. cit., S. 107–109), eventually become sarcomatous, just as they might do were the muscle cells themselves normal, thus forming a pure sarcoma. It is therefore theoretically possible for a myoma subsequently to become sarcomatous in this manner; but such a tumor, if it exist, would be more correctly named a sarcomatous myoma, or a myoma sarcomatodes, than a myosarcoma. And from our knowledge of pathological processes in general it appears hardly safe to conclude that muscle cells, even when already perverted into tumor formation, can subsequently, by metaplasia, become sarcoma cells. It seems to us more rational to look upon these myomata as being either sarcomatous tumors in muscular tissue (*myosarcoma ab origine*), or as being examples of leiomyoma malignum, as described by Devic and Gallavardin and by Giuliani. It may be mentioned in passing that similar tumors giving muscular metastases have been described in connection with the uterus.

Further confusion is added to the subject by the class of myomata in which angeiomatous changes exist. Some of these tumors are undoubtedly malignant, and are classed by some writers as angeio-sarcomata, and by others as endotheliomata (von Bergmann; Nichols). Cyst formation is frequent in these angeio-myomata.

Magnus-Alsleben observed post-mortem five patients with adenomyoma of the stomach, and he concludes that in these tumors the adenoma is the primary change, and that it is later crowded out, so to speak, by the myomatous overgrowth. Some authors have regarded certain instances of hyperemesis lactantium as due to a congenital myoma of the pylorus. (See p. 134.)

In a case recorded by Monro and McLaren, a pedunculated

myoma near the pylorus was present in a stomach on whose lesser curvature was a carcinoma. The two growths had no connection.

Operative treatment should be undertaken as soon as a gastric myoma makes its appearance known. It is usually possible to remove the growth by resection of that part of the gastric wall from which it sprang; but occasionally formal excision (partial gastrectomy) is required. Operations for gastric myomata have been performed by:

1. Bircher (Med. Klinik, 1908, iv, 223, Fall 2). Resection of pedunculated fibromyoma from anterior wall of stomach. Died 6 days later. No peritonitis. Tumor weighed 380 grammes.
2. Ehrenberg (Perls and Neelsen: Allgemein. Pathol., Stuttgart, 1886; cited by Cohn: Inaug. Dissert., Greifswald 1903). Resection of myoma from stomach. Cohn does not mention result.
3. Eiselsberg (Arch. f. klin. Chir., 1897, liv, 599). Resection of immense tumor (myoma sarcomatodes) from greater curvature of stomach. Recovery.
4. Erlach (Wien. klin. Woch., 1895, viii, 272). Enucleation of immense myoma from between layers of gastro-hepatic omentum, and from lesser curvature of stomach. Recovery.
5. Goullioud (Giuliani: Thèse de Lyon, 1904, Obs. II). Partial gastrectomy (Billroth II) for leiomyoma malignum of pylorus, growing between layers of gastrocolic omentum. Recovery.
6. Helferich (Moser: Deutsch. med. Woch., 1903, xxix, 157). Resection of part of lesser curvature of stomach, for myoma sarcomatodes. Died from peritonitis on fifth day.
7. Herhold (Deutsch. med. Woch., 1898, xxiv, 60). Resection of small nodule (myoma) from pylorus, with pyloroplasty. Recovery.
8. Laroyenne (Goullioud and Mollard: Lyon Méd., 1896, lxxxii, 257; cited by Giuliani: Thèse de Lyon, 1904, Obs. I.). Enucleation of large growth from gastrocolic omentum. Died in 6 hours of shock. At autopsy the primary tumor (leiomyoma malignum) was found in stomach at left extremity of greater curvature.
9. Moser (Deutsch. med. Woch., 1903, xxix, 133). Incision for left kidney tumor. Mass found to spring from posterior

wall of stomach. Resection of posterior gastric wall and part of pancreas. Myosarcoma. Recovery.

10. Nicoladoni (Steiner: Beitr. z. klin. Chir., 1898, xxii, 1, Fall 2). Resection of part of greater curvature and transverse colon for fibromyoma. Died from peritonitis on eighth day.
11. Ochsner (Yates: Annals of Surgery, 1906, ii, 599. Case 1). Partial resection of posterior gastric wall for pedunculated subserous myoma. Recovery.
12. Poirier (Bull. et Mém. de la Soc. de Chir. de Paris, 1902, xxviii, 273). Resection of small nodule (myoma) from pylorus with pyloroplasty. Recovery.
13. Rupprecht (Kunze: Archiv. f. klin. Chir., 1890, xl, 756). Large growth (angeio-myoma) growing in layers of gastro-colic omentum excised with partial resection of anterior gastric wall near cardia, from which region the tumor sprang. Died on fifteenth day from pneumonia.
14. Samter (Deutsch. med. Woch., 1904, xxx, 914). Partial gastrectomy (Billroth II) for myoma of pylorus. Recovery.

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Cases of Myoma.

(Additional to Steiner's tables.)

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Gouillioud: see Giuliani, Thèse de Lyon, 1904.
Jean: Bull. et Mém. Soc. Anat. Paris, 1875, l, 20.
Kidd: Trans. Path. Soc. London, 1883–4, xxxv, 196.
Magnus-Alsleben: Virchow's Archiv f. path. Anat., 1903, clxxiii, 156.
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Monro: Glasgow Med. Jour., 1901, lv, 115.
Moser: Deutsch. med. Woch., 1903, xxix, 133; 157.
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Adenoma and Papilloma. Gastric adenomata are met with in two forms: (A) Sessile pedunculated growths, usually single, and practically indistinguishable from mucous papillomata; (B) Polyadenomata, or mucous polypi.

(A) The former variety, which is usually understood when the term **adenoma** is employed, projects into the cavity of the stomach, usually in the pyloric region, in the form of a rounded, smooth or slightly lobulated tumor, evidently composed almost solely of hypertrophied mucous membrane. When solitary such tumors have been known to grow to the size of an apple, or even to that of a fœtal head at term (Chaput). Sklifossowsky recorded under the name of papilloma of the stomach two cases presenting much the same macroscopic and microscopic appearances as adenomata. Mauler collected all cases of adeno-papillomata recorded up to 1898. Hayem called attention to two cases of adenoma the structure of which resembled Brunner's glands, and which appeared to originate in the mucosa; the same condition has been since observed by other pathologists. These tumors usually rapidly penetrate the muscularis mucosæ, and proliferate in the submucous tissues. The more usual form of adenoma is strictly a mucous growth. It proliferates above the muscularis mucosæ, projecting into the cavity of the stomach; it very rarely becomes ulcerated, unless malignant, or unless it proliferates around the border of a gastric ulcer. It is usually single, but several may be present in different parts of the stomach.

When pedunculated, and with enough fibrous tissue in its pedicle to warrant the name of fibro-adenoma, this tumor forms one of the commonest varieties of gastric polypus. An intragastric polyp may occlude the pylorus, thus simulating pyloric stenosis from other and more frequent causes; and when easily displaced may produce intermittent dilatation of the stomach, as in a remarkable case reported by Bennett (Figs. 26, 27). In one case quoted by Fenwick fatal intussusception of the duodenum was produced by a polyp just below the pylorus.

In general it may be said that a fully developed gastric polyp is more apt to produce symptoms than is any other form of benign

gastric tumor. Multiple polypi were found by Stevens at autopsy on a patient who had been subject to constant epileptic fits, with an aura arising in the stomach. Such cases are of interest in connection with the subject of gastric tetany. McCosh has recorded a case of gangrenous gastritis from strangulation of a polyp in the stomach.

It is difficult to draw a boundary line between adenomatous changes frequently encountered in the stomach, in association with unhealed ulcers, and certain histological appearances which by some pathologists are considered pre-cancerous in nature. For a further discussion of pre-cancerous changes the reader is referred to the chapter on Gastric Carcinoma (p. 272). The relation of

Fig. 26.—Polypus of Stomach near Pylorus.

Fig. 27.—Gastric Polypus near Pylorus, Acting as Ball-valve.

myoma to adenoma, studied by Magnus-Alsleben, has already been referred to at p. 217.

(B) **Polyadenomata,** or **mucous polypi** of the stomach, are usually regarded as in some way the result of chronic gastritis. They are as a rule widely distributed over the interior of the stomach, transforming its surface into a pulpy mass, from which mucus can readily be squeezed. Each polyp is more or less distinct from the others, and none are larger than peas or small cherries. The centre part, or stalk, of each individual tumor is composed of fibrous tissue, containing blood vessels and lymphatics, and representing the normal submucosa. Over this core a thickened hypertrophied layer of smooth muscular tissue is found, corre-

sponding to the muscularis mucosæ; while the free surface of the tumor, frequently cystic, is composed of hypertrophied and tortuous mucous glands. These dilated glands are said to resemble closely the uriniferous tubules in the cortex of the kidney. According to Ménétrier, the cysts result from involvement of the ducts of the glands; whereas when the fundi of the glands are chiefly affected, the cysts are few in number and of small size. These mucous polypi are freely movable over the subjacent tissues, and the neighbouring lymphatic nodes are never affected. Yet Norman has recorded a case of polyadenomata, apparently belonging to this class, in which the change was not considered malignant although the glandular tissue had broken through the muscularis mucosæ and proliferated in the submucous tissue. Bier has recently done gastro-jejunostomy for a similar affection (diffuse polyposis), the patient being reported as improved 18 months later, although microscopical examination of a portion of the gastric mucosa had shown "early malignant changes."

Ménétrier also describes a form of mucous polypus which he calls "*polyadenome en nappe*," in which condition the adenomatous formation is not confined to any circumscribed area or areas, with the formation of distinct polypi; but the hypertrophy and hyperplasia affect simultaneously all the glands over a fairly large area, or even through the whole stomach.

All these adenomatous tumors (the adenoma proper and the mucous polypi) have these distinguishing histological features: they are separated on the one hand from simple inflammatory or hypertrophic changes by the fact that although there is hyperplasia of the glandular structures, yet the pepsin or oxyntic cells present in normal glands fail to be reproduced in the adenomatous neoplasms; and, on the other hand, they are distinguishable from adeno-carcinoma by the fact that nowhere may the epithelial cells of the adenoma be found to have penetrated the muscularis mucosæ or to be deprived of their normal basement membrane.

Symptoms.—Unless pedunculated, adenoma of the stomach is characterized by no very well defined symptoms. In cases recorded by Gourrand, and by Quain and Beardsley a gastric

polypus was vomited. In the case of mucous polypi the patient may complain of constant gastric discomfort, and nausea may be a prominent feature of the case. This condition has been suspected during life, and the suspicion confirmed at autopsy, in the case of patients who have suffered from a sensation of worms crawling around the stomach.

A correct diagnosis can rarely be made; it is sometimes possible, however, to determine the presence of a benign tumor. In other cases an exploratory operation is undertaken for the symptoms of pyloric stenosis, or even of prolonged gastric indigestion. Usually it has been possible to excise the tumor with or without partial resection of the gastric wall. Many more such operations are recorded for adenomata which showed malignant changes than for those which were undoubtedly benign. Operations for the removal of gastric adenomata have been recorded by:

1. Lange (N. Y. Med. Jour., 1892, lv, 584). Partial resection of anterior gastric wall for ulcerated benign adenoma. Recovery.
2. Chaput (Bull. et Mém. de la Soc. de Chir. de Paris, 1895, lxx, 534). Gastrotomy: partial resection of posterior gastric wall for immense fibroadenomatous polypus. Recovery.
3. Lyman (Annals of Surgery, 1896, ii, 310). Gastrotomy: amputation of pedunculated adeno-carcinoma from posterior wall of stomach. Death in one month.
4. Bennett (Brit. Med. Jour., 1900, i, 241). Gastrotomy. Papillomatous polyp amputated from pyloric region. Recovery.
5. Robson and Moynihan (Dis. of Stomach, N. Y., 1904, p. 75). Sessile adenoma excised from pylorus, with pyloroplasty. Recovery.
6. Hinds (Robson and Moynihan: Surg. Treat. Dis. of Stomach, N. Y., 1904, p. 76). Gastrotomy; resection of polypoid adenoma from posterior wall of pylorus. Recovery. Gastro-jejunostomy 18 months after, with death from exhaustion in 48 hours.

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Lipoma. Lipoma of the stomach is referred to by Virchow. These tumors may arise in either the submucous or the suberous adipose tissue. According to Cruveilhier, small lipomata, the size of peas or beans, are not unusual. In such cases the masses of fat are probably not heterologous, but merely a localized increase in the amount of fat normally present. Cohn has recently reported finding at autopsy on a patient with malignant gastric myoma, a small submucous lipoma at the pylorus. It is to the larger tumors, which may more justly be recognized as neoplastic in character, that this paragraph has special reference. Hartmann in discussing in 1905 a case of submucous lipoma of the pyloric antrum, found at autopsy by Benaky, of Smyrna, says that the only cases reported up to that time were the following:

1. Cruveilhier; Submucous lipoma.
2. Virchow; Submucous lipoma.
3. Tilger; Submucous lipoma.
4. Tilger; Submucous lipoma.
5. Fenwick; Submucous lipoma.

To these should be added four other cases (all subserous) of gastric lipoma: two recorded by Russdorf, and one each reported by Orth and Murray. Fischer has reported a case of fibro-lipoma of the stomach in a woman aged 37 years, which had caused pain in the left epigastric region for about a month. An epigastric hernia developed, but there was no vomiting, no hemorrhage and no indigestion. The left rectus was rigid, and a diagnosis was made of recent inflammatory processes in a tumor of long standing, though no tumor was palpable. Operation showed the hernia to be an epiplocele, and the tumor was found on the lesser curvature of the stomach, not involving the mucous membrane. It was successfully resected; and microscopical examination showed a fibro-lipoma, with acute inflammation and hemorrhage into the substance of the tumor. The convalescence was delayed by five attacks of tetany on the seventeenth day after operation.

In none of these patients, except Fischer's, was operation undertaken; but as all the tumors were easily enucleated at autopsy, it would be perfectly proper to attempt their removal by gastrotomy, should their presence be discovered during life.

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Russdorf: Deutsche Klinik, 1867, xix, 115.
Tilger: Arch. f. path. Anat., 1893, cxxxiii, 183.
Virchow: Path. des Tumeurs, Paris, 1867, i, 369.

Cysts. Cysts are found in the stomach either as retention cysts of the mucous glands, or as the result of traumatism or the degeneration of other forms of tumor. There are also on record one case of dermoid cyst and a few cases of hydatid cysts. The dermoid cyst (Ruyschius) contained hair, teeth attached loosely to bone, and other matters almost too wonderful for belief. Three of the hydatid cysts were found at autopsy; two (Bochlendorf; Barton) involved the stomach in the course of their developement, but did not originate in the gastric wall; while in the case recorded by Castellvi y Pallares the gastric wall seems to have been the primary seat of growth. A fourth case of hydatid cyst has been recorded by Hartmann; at the operation, by Dujarier, the cyst was found to have developed between the mucous and muscular coats of the stomach; it was successfully excised. Tuffier has operated on a patient with hydatid cyst developing in the gastro-hepatic omentum, and thus simulating a tumor of the lesser curvature of the stomach.

Numerous small cysts of the mucosa are frequently seen in certain forms of gastritis. They are true retention cysts, the inflammation obliterating the glandular orifices—a pathological change seen to an even more marked degree in the developement of adenomata. These small retention cysts have practically no surgical interest, unless in connection with polyps or adenomata.

Traumatic cysts of the stomach are very rare. Ziegler and Chutro have each successfully operated on such a case. As shown in Chutro's valuable contribution to the literature of gastric cysts, the history is that of severe traumatism to the epigastric and left hypochondriac regions. Shock, pain, and persistent vomiting, but without evidences of peritoneal infection, are the immediate symptoms. A little blood may be vomited or passed from the bowels. After a few days or weeks, the more acute symptoms subside, though vomiting may persist; and the physical signs are more accurately localized to the stomach. A semi-fluctuating tumor may form. It is difficult to distinguish this from an encysted peritonitis; but the absence of suppurative signs will be an important clue. No time should now be lost in evacuating the contents of the cyst by laparotomy; suture of the cyst to the parietal

peritoneum and drainage effected a cure in both patients. The cyst forms as the result of hemorrhage into the subserous (Zeigler) or submucous tissues (Chutro), aided perhaps by the effusion of gastric juice from the deeper portions of the mucous membrane, which in Chutro's patient was intact. The cyst, at first hemorrhagic, soon becomes serous or sero-purulent in character. The dangers of delay in operating are: (1) Infection of the cyst from stomach contents; (2) intraperitoneal rupture of the cyst, causing peritonitis; (3) rupture of the cyst into the stomach, creating a septic perigastric abscess. Any of these events may be responsible for death in patients with gastric cysts not of traumatic origin.

More frequent are cysts which occur as the result of **degeneration** of other forms of tumors. According to Virchow, cyst formation is a not unusual termination of fatty tumors; and it is certainly true that most of the gastric cysts reported have contained fluid resembling disintegrated blood clot and fat. The large cyst surrounding the anterior wall of the stomach, found post-mortem by Read, appears to have originated as a submucous lipoma which afterward underwent malignant change; while the remarkable case recorded by Hutchinson and Sloane in which a walnut sized cyst was found at autopsy, being both subserous and submucous, and its two sacs communicating by a narrow orifice in the muscular tunic, was possibly also of the same derivation, the contents being pinkish, thick, opaque, and glittering with plates of cholesterine. Albers observed a cyst of the lesser curvature at autopsy on a child. Hebb and Finnel have each recorded a gastric cyst which Fenwick classes as serous. In Hebb's case the cyst was lined with epithelioid cells, and may therefore have been lymphangeiomatous in origin. Finnel's patient also had carcinoma of the pylorus. Cases in which a probable hemorrhagic origin can be traced have been reported by Rendu, by Gallois, Hontang and Leflaive and by Anderson. Some of these so-called hemorrhagic cysts may have been due to forgotten injuries, but it is probable that most of them were degenerations of pre-existing tumors. In the case recorded by Fenwick this origin is more certain in view of the lymphangeiomatous structure which is mentioned. A true lymphangeiomatous cyst has been

reported by Engel-Reimers, in whose patient the presence of an intensely deforming scar near the lesser curvature made it seem likely that the subserous cyst of lymphangeiomatous structure was not a true neoplasm, but merely a retention cyst due to the obstruction to the lymph channels by the cicatrix already described.

There remains to be discussed the extremely rare affection **"Gaseous cysts."** This disease, well known to the veterinarian from its frequent occurrence in swine, has been studied in its human relation by Hahn and by Holstein. According to these authors the disease was first noted at autopsy, in 1754, by Duvernoy. Cloquet in 1820 reported a case of gaseous cysts (submucous and subserous) of the stomach and intestines. He had also observed it in the hog. Mayer in 1825 determined that the gas in these cysts was composed of oxygen and nitrogen, 15.44 parts of the former to 84.56 parts of the latter. Gaseous cysts of the vagina and of the bladder have also been noted. Dupraz in 1897 found that the gaseous cysts of a stomach studied by him were dilatations of the lymph spaces, and that they were accompanied by chronic lymphangeitis. There is no doubt as to the bacterial origin of some of these cysts, but different micro-organisms have been found by different observers Hahn, Jaboulay, and Vallas have operated on patients with gaseous cysts. Finney has recently published a paper based on a study of 19 collected cases of gaseous cysts of the gastro-intestinal tract.

Operative treatment has been undertaken in the following cases of gastric cysts.

1. Rendu: Hemorrhagic cyst aspirated three times, and finally drained by a large canula. Death from peritonitis.
2. Gallois, Hontang and Leflaive: Hemorrhagic cyst punctured twice. Death after many months from intraperitoneal rupture of the cyst.
3. Zeigler: Traumatic cyst opened and drained. Recovery.
4. Winands: Intestine punctured for obstruction. True condition found five years later at autopsy.
5. Anderson: Hemorrhagic cyst opened and drained. Death in 24 hours of exhaustion.
6. Hahn: Multiple gaseous cysts. Excision of those that were pedunculated, and puncture of others. Recovery.

7. Jaboulay explored abdomen of patient with gaseous cysts, did pylorodiosis by Hahn's method, and, believing the cysts were due to some low grade inflammatory process analogous to tuberculosis, closed abdomen without drainage and without interfering with cysts. Recovery.
8. Vallas: Exploratory operation for intestinal obstruction with peritonitis. No cause found. Abdomen drained. Death. At autopsy innumerable subserous and submucous gaseous cysts of stomach and intestines. The submucous cysts had in some places caused intestinal obstruction.
9. Chutro: Traumatic cyst opened and drained. Recovery.

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Winands: Beitr. z. path. Anat., 1895, xvii, 38.
Zeigler: Münch. med. Woch., 1894, xli, 103.

Osteoma. That it is not impossible for a gastric tumor to undergo osteoid transformation is proved by the unique case reported by Webster. He found at autopsy on a patient who had died with symptoms of intestinal obstruction, that the pylorus was plugged as with a cork by a cartilaginous tumor, with numerous spiculæ of bone, which was adherent to the gastric wall near the pyloric orifice.

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Concretions have been found in the stomach occasionally. They are generally due to the long continued use of mineral substances (bismuth, etc.) as medicines. Fenwick refers to four instances in which such concretions were composed of shellac or varnish. In the museum of the Academy of Natural Sciences of Philadelphia there is a remarkable specimen of a large gastrolith from a horse, deposited by Dr. John Ashhurst, Jr.

REFERENCE.

Fenwick: Cancer and Other Tumours of the Stomach, London, 1902, p. 325.

Angeioma. Stockis, at the autopsy on a twelve day old infant, who died in convulsions after profuse hæmatemesis and melæna, found a capillary angeioma, in the submucous and muscular tissue of the stomach near the cardia, which was proved to be the source of the hemorrhage. In connection with sarcoma and myoma angeiomatous changes are not unusual.

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Lymphadenoma. Gilly collected in 1886 51 cases of gastro-intestinal lymphadenoma, the stomach being involved in 14 instances. A few cases have been recorded since (Pitt). In

all known cases, lymphomatous growths have been observed in other parts of the body as well —in the spleen, lymph nodes, bones, pharynx, or intestines. In all cases of gastric lymphadenoma, the intestines were also involved. This affection arises either in the subserous or submucous lymphatic tissues of the stomach. In the submucous tissues it exists either as a localized or diffused form, usually manifesting itself on the surface of the stomach by a polypoid condition of the mucosa. Ulceration is more usual in the circumscribed form. The tumors which arise in the submucous tissues rarely cause obstruction, but those commencing in the subserous tissue, and which are usually diffuse, frequently penetrate, paralyse, and ultimately destroy the muscular coat, producing dilatation of the stomach and consequent stagnation of food. In some cases it appears to have been demonstrated that the disease originated in the neighbouring mesenteric lymph nodes, and subsequently involved the subserous lymphatic structures of the stomach.

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Plastic Linitis. This term was used by Brinton to describe a disease which had been previously studied, but had not been named, by Andral. It is an affection characterized patholgically as a diffuse sclerosis of the stomach, involving especially the submucous tissues, and accompanied by marked thickening of the gastric walls, and by a diminution in the capacity of the stomach. The process usually commences in the pyloric region, and gradually spreads, without affecting the mucous membrane, until the entire wall of the stomach becomes thickened and rigid, and its lumen much diminished in size. There have been many other synonymous terms employed to describe the same condition. Among the best known are: Cirrhosis of the Stomach; Zuckergussmagen; Submucous Sclerosis; Endogastritis Obliterans; Magenschrumpfung; etc. The causes to which this pathological change have been attributed are many. Carcinoma and syphilis sometimes produce a profuse gastric infiltration which even microscopically is distinguishable from this affection only with the greatest difficulty. Some cases of hyperemesis lactantium seem to be caused by an identical submucous sclerosis. Plastic linitis is usually regarded as benign, and is considered by most of those who have given most attention to the subject, a special disease entity. The best articles recently published are those of Brissaud, of Jonnesco and Grossman, and of Kurt von Sury. The latter concludes that cirrhosis of the stomach is due to the same cause as polyserositis, namely chronic passive hyperæmia from cardiac insufficiency. Jonnesco and Grossman believe that it is simply a chronic inflammatory change, and in no way neoplastic in character. Histologically it appears to be nearly related to the lymphadenomatous changes just described. Its connection with chronic obstruction of the efferent lymph vessels of the stomach does not appear to have received sufficient attention. Its relations with endothelioma and sarcoma are not clear.

By microscopical examination it is sometimes impossible to say whether the epithelioid cell nests which infiltrate the submucous and muscular tissues are really epithelial in derivation (carcinoma), or due to proliferation of previously existing endothelial

cells lining the lymph channels which normally exist in these situations. (See Jaboulay's case of subtotal gastrectomy for an infiltrating growth thought by Gayet and Patel to be epitheliomatous.)

As the question of the pathology of this affection is still *sub judice*, it is probably safer at present to regard it as a pathological change which may arise in several different diseases—carcinoma, syphilis, pericardial adhesions, lymphatic obstruction, etc.

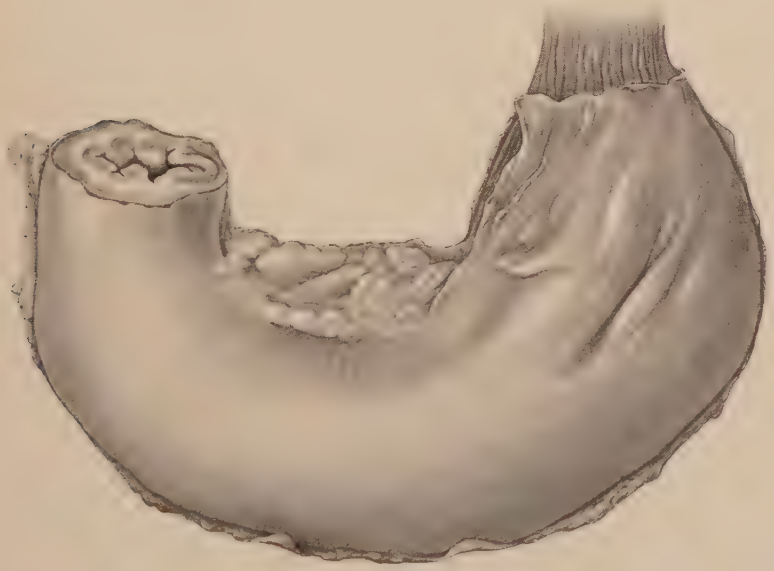

Fig. 28.—Total Contraction of the Stomach (Magenschrumpfung) from Plastic Linitis. Natural Size. (*From a specimen in the Museum of the German Hospital.*)

Treatment must usually be palliative. Should the change be recognized early enough, *partial gastrectomy* should be attempted. In a somewhat similar case Sheldon did *gastro-jejunostomy*, and reported his patient in good health three years and a half later. In cases of pyloric stenosis, such as those recently reported by Mansell Moullin, where no evidence of ulcer, past or present, could be detected, but where the obstruction appeared to be caused by fibroid thickening, *Finney's operation of pyloroplasty* may bring

relief, as it did in the seven patients reported by Moullin. If the disease has progressed so far as practically to obliterate the cavity of the entire stomach, *duodenostomy* should be done; or if the disease has invaded the duodenum, jejunostomy may be the last resort. This operation was adopted in one case of this disease by v. Eiselsberg, with gratifying result, the patient still using the fistula with comfort five years after the operation.

Jonnesco and Grossman refer to operations of pylorectomy for this condition recorded by Delbet and Brissaud, in 1900, and by Chaput and Œtinger in 1901. They state that gastro-jejunostomy was done by Chaput and Pilliet in 1896, and by Roux of Lausanne in 1904. In their own patient gastrostomy was done; as the cavity of the stomach was nearly obliterated, and as the pylorus would not admit the passage of a tube into the duodenum, this first operation was followed after four days, when the patient's strength had somewhat increased, by a jejunostomy in Y. But the patient preferred to swallow his food; and as the gastrostomy wound became very much inflamed from the escape of the ingested food which could not pass the pylorus, an attempt was made about four weeks later to close the gastric fistula. Unfortunately the patient died of exhaustion two days later. The result of this case shows, as Jonnesco and Grossman affirm, that jejunostomy is better as a primary operation than gastrostomy. Leersum treated a patient with "endogastritis obliterans" by pyloroplasty; but as improvement did not continue, he performed total gastrectomy three weeks later, doing an œsophago-jejunal anastomosis. The patient recovered and gained twenty pounds in weight. Morone has recorded a case of plastic linitis, clearly epitheliomatous in character, in which Tansini did partial gastrectomy; the patient was in good health 14 months later. One patient with diffuse fibrosis of the stomach, clinically resembling plastic linitis, has been operated on by Dr. Deaver at the German Hospital:

Case. Frank K., aged 46 years. Two uncles died of pulmonary tuberculosis. When 22 years of age the patient was accidentally inoculated with syphilis, developing a chancre on the thumb. Had anti-syphilitic treatment for 2 years. In 1903, three years before

admission to the German Hospital, he had an attack of pyelitis, after the passage of a urethral sound. Following this illness he suffered from acute gastritis, having hiccoughed for 11 days. For the last 2 years has suffered from pain and tenderness in the epigastrium. He vomited only when he forced himself, and then brought up food taken one or two days previously. No hæmatemesis or melæna. For past 7 months no food but milk. Has lost 100 lbs. in weight. Says he cannot retain more than 6 oz. in his stomach at one time. Physical examination was negative except for tenderness and rigidity in the epigastric region. Examination of his stomach contents showed: total acidity 10; no free hydrochloric acid; no lactic acid; no Oppler-Boas bacilli. Blood-count: R. B. C., 3,410,000; W. B. C., 8,000; Hb. 62 per cent.; colour index 0.8.

Operation June 3, 1906. The stomach was found much contracted, its walls dense and fibrous, and resembling in appearance and shape the small bowel. Posterior gastro-jejunostomy was done, the gastric wall being an inch in thickness. Recovery was uneventful, and the patient is now in good health, nearly $2\frac{1}{2}$ years after the operation.

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CHAPTER X.

MISCELLANEOUS AFFECTIONS OF THE STOMACH AND DUODENUM.

Tuberculosis of the Stomach is rare. There are somewhat more than one hundred cases recorded. According to Curschmann, in 900 autopsies on tuberculous subjects Dürk found the stomach involved in only 4 cases; and in 2000 autopsies Simmonds found only 8 tuberculous ulcers of the stomach; while Glaubitt, according to Barchasch, noted 47 tuberculous ulcers in autopsies on 2237 tuberculous patients. Adler compares these figures with 11 cases of tuberculous gastric ulcer found in 839 autopsies on tuberculous children; which makes it appear rather less unusual in children than in adults. Ricard and Chevrier have recently written an elabourate paper on the subject of Tuberculosis and Tuberculous Stenosis of the Pylorus; and much of what follows is abstracted from their valuable article.

Louis, in 1825, first recognized tuberculosis of the stomach; but Hattute (1874) was the earliest to note pyloric stenosis from tuberculosis; and it was not until 1894 that the subject was brought prominently before the profession by Durante.

It is important, in the first place, to distinguish between gastric ulcers occurring in tuberculous patients, and those ulcers due to the local action of the tubercle bacillus. The former may be of the ordinary type ("round," "acute," "chronic," etc.) or in some instances may be due to the toxæmia of tuberculosis localized in other parts, the ulcers thus resembling in origin those erosions on which Dieulafoy and more recently his pupil Gandy have laid such stress, as caused by the toxæmia of various infectious diseases. If the toxæmia of tuberculosis give rise to mucous erosions in the stomach, these erosions may later become infected with the tubercle bacillus, either ingested with the food, or swallowed with the

sputum. Or a true tuberculous ulcer may possibly arise *de novo*, without the previous existence of an erosion or an open ulcer. Secondary infection of an already existing gastric lesion is probably much the more frequent origin. The portal of entry is usually through the gastric mucous membrane, from the cavity of the stomach; though infection by the blood and lymph streams is also recognized as possible. The rarity of the affection is no doubt due to the short time that the ingesta normally remain in the stomach, as well as to the antiseptic action of the gastric juice. Certainly intestinal tuberculosis is much more frequent than is gastric (Barchasch says the intestines are involved in from 47 to 63 per cent. of phthisical patients who come to autopsy); and gastric tuberculosis when it does occur is in the immense majority of cases secondary to some tuberculous lesion in other parts of the body, particularly the lungs or bronchial lymph nodes. According to Van Valzah and Nisbet, "sometimes the only detectable local lesion is tubercle of the choroid or a laryngeal or nasal ulcer." They also remind the reader that the tubercle bacillus may be found in the urine when it is absent from the sputum. Its differentiation from the smegma bacillus is important, when search is made for it in the urine. According to Alessandri there were in 1905 only four authentic cases of primary gastric tuberculosis on record. Barchasch (1907) admits six cases as examples of undoubted primary tuberculosis of the stomach.

The tubercle bacillus may pass through the gastric mucosa, leaving it intact, and lodge and proliferate in the neighbouring lymph nodes. This is very unusual. When the lymph nodes have been long involved, whether primarily or secondarily diseased, they become caseous and sometimes calcareous. Those along the lesser curvature may soften and rupture into the cavity of the stomach; but at the pylorus the thickness of the wall is so great as to prevent this termination. Peripyloric tuberculous lymphatic involvement is sometimes a cause of pyloric stenosis without lesions of the gastric mucous membrane.

Poncet and Leriche distinguish three main forms of surgical tuberculosis of the stomach: an ulcerated form, which is rendered

surgical only by its complications; an hypertrophic form, the gastric tuberculoma, simulating carcinoma; and finally an inflammatory form, which differs from other forms of gastritis only in its ætiology.

Gastric tuberculosis is almost always ulcerated. The disease affects by preference the submucous and subserous tissues, the muscular tunic escaping as a rule. But in the pyloric region, where the disease usually assumes the hyperplastic form, the muscular coat is prone to invasion. In the body of the stomach tuberculosis is usually diffuse. The ulcers are ragged, undermined, leaving free overhanging edges of mucosa; and when of long duration are seated on characteristic raised and thickened bases, called by the French "*remparts*." The ulcer often assumes the transverse character, parallel with the blood vessels, as are the similar ulcers of the intestine. Perigastritis usually occurs in time to protect against perforation into the abdominal cavity; and hemorrhage also is rare. In some cases the duodenum has been opened by ulceration, forming a gastro-duodenal fistula. This may temporarily relieve the symptoms of pyloric stenosis. The colon has also been penetrated by the ulceration of a tuberculous gastric ulcer. Perforation of the œsophagus by a tuberculous ulcer was the cause of death in a patient of Giorgi, who was found at autopsy also to have had tuberculous ulcers of the stomach.

Among the 107 cases of gastric tuberculosis studied by Ricard and Chevrier there were only three in which no other portion of the digestive tract was involved in tuberculous disease. The small intestine, the mesenteric lymph-nodes, and the cæcum are oftenest affected.

The **symptoms** are those of gastric ulcer. Pyloric stenosis from tuberculous hyperplasia is one of the least usual forms of the disease. When present, it is not difficult to detect the stenosis, by the usual symptoms and physical signs; but it is only by a searching examination for tuberculous lesions elsewhere in the body that the ætiological diagnosis of the gastric lesion can be made. The tuberculin test may aid in determining the question. At operation it is frequently very difficult to distinguish these cases from those

of pyloric carcinoma. Inflammatory hyperplasia, plastic linitis, and even syphilis have to be considered.

The **prognosis,** so long as there is no pyloric stenosis, depends rather upon the other tuberculous lesions in the body than upon those in the stomach. If pyloric stenosis is present, the prognosis is absolutely bad, without operation.

The **operative treatment** of gastric tuberculosis has so far accomplished little beyond relieving the most distressing symptoms and moderately prolonging life. We have found references to over twenty operations for this condition. In 18 instances sufficient details are available for analysis. Of these 18 patients, 5 died as a consequence of the operation, while 13 survived for varying periods. Of these thirteen surviving patients, 8 have been traced to their death, which occurred at an average period of eight months after the operation. A ninth patient survived for three and one-half years, and then died from an abscess of the liver, the exact cause of which could not be determined at autopsy. Four patients who survived operation for some time were well when reported, but the period elapsed was too short to be conclusive.

Operation is not advisable except to relieve pyloric obstruction; but if it can be determined that other tuberculous lesions in the body are not such as to render the expectation of life unreasonably limited, it may be proper in selected cases to undertake exploratory laparotomy with a view of prolonging life by improving nutrition through the means of some palliative operation. Ricard and Chevrier severely condemn all attempts at excision as futile and extremely liable to disseminate the tuberculous process. If, however, the disease is limited to the pylorus, and especially if the tuberculosis is primary in the stomach, partial gastrectomy should be preferred. It has been successfully employed by Alessandri and by Docq. In other cases the nature of the operation will depend upon the local conditions and upon the extent of constitutional involvement. Gastrolysis may be sufficient when the pyloric obstruction is caused by perigastric tuberculous peritonitis. In most cases gastro-jejunostomy is the operation of choice. In some patients pyloroplasty may give satisfactory results.

Operations have been performed on patients with gastric tuberculosis by:

1. Ricard (Revue de Chir., 1905, xxxii, 97). In 1889, anterior gastro-jejunostomy, followed by entero-anastomosis four days later for vicious circle. Recovered. Died 18 months later of tuberculous peritonitis.
2. Durante (Cited by Ricard and Chevrier: Revue de Chir., 1905, xxxii, 81). In 1893, pyloroplasty (by Durante's method). Recovered. Ultimate result not stated.
3. Durante (Ibid.). In 1893, gastro-jejunostomy. Recovered; but another operation was done one month later for diffuse miliary tuberculosis of peritoneum. Ultimate result not stated.
4. Ferrari (Cited by Alessandri: Bull. d. r. Accad. med. di Roma, 1905, xxxi, 267). In 1893, posterior gastro-jejunostomy. Recovered; but died four months later of phthisis.
5. Durante (Cited by Alessandri: Bull. d. r. Accad. med. di Roma, 1905, xxxi, 267). In 1895, gastro-jejunostomy. Died.
6. Mayo Robson (Lancet, 1902, ii, 851; Diseases of the Stomach, N. Y., 1904, p. 455). In 1895, pyloroplasty. Died in two weeks.
7. Margarucci (Il Policlinico, 1898, v, Sez. Chir., 250). In 1898, anterior gastro-jejunostomy, and two enteroplasties for tuberculous strictures of ileum. Died in three days.
8. Herczel (Cited by Alessandri: Bull. d. r. Accad. med. di Roma, 1905, xxxi, 267). In 1899 posterior gastro-jejunostomy. Symptoms unrelieved. Three months later, anterior gastro-jejunostomy. Improved. Still later pylorus was excised. Death followed in six months from pulmonary phthisis. A biliary fistula had persisted since last operation.
9. Ricard (Revue de Chir., 1905, xxxii, 97). In 1901, gastrolysis, with suture of subacute perforation of stomach, from tuberculous ulcer. Recovered, but died some months later from perforation and internal hemorrhage.
10. Ricard (Ibid.). In 1901 posterior gastro-jejunostomy. Recovered; but died in less than one year of tuberculous peritonitis.
11. Verhoogen (Goddart-Danhieux: La Policlinique, Bruxelles, 1901, x, 185). In 1901, gastro-jejunostomy. Died same evening.
12. Verhoogen (Godart-Danhieux, Ibid., loc. cit., p. 481, cited by Ricard and Chevrier: Revue de Chir., 1905, xxxii, 97). In 1901, gastro-jejunostomy and plastic operation on colon. Died in four days.

13. Chevassau (Cited by Ricard and Chevrier: Revue de Chir., 1905, xxxii, 97). In 1902, posterior gastro-jejunostomy. Recovered. Died three and one-half years later, from abscess of liver of undiscoverable origin.
14. Ricard and Chevrier (Revue de Chir., 1905, xxxii, 97). In 1903, posterior gastro-jejunostomy. Relieved, but died in a few months.
15. Petersen (Curschmann: Beitr. z. Klin. d. Tuberk., 1904, ii, 127). In 1904, posterior gastro-jejunostomy. Relieved. Died in less than three months of phthisis.
16. Rüge (Beitr. z. Klinik d. Tuberk., 1905, iii, 191). In 1905, pyloroplasty. Relieved, but in two months posterior gastro-jejunostomy done for recurrence of symptoms. Died fourteen months after first operation.
17. Alessandri (Bull. d. r. Accad. med. di Roma, 1905, xxxi, 267). In 1905 partial gastrectomy (Kocher's method), for tuberculous stenosis of pylorus. Recovered, and in good health forty-five days later.
18. Mattoli (Cited by Alessandri, loc. cit.). Recurrent case; no details.
19. Mattoli (Cited by Alessandri, loc. cit.). Recurrent case; no details.
20. Durante (Cited by Alessandri, loc. cit.). Gastro-jejunostomy; very recent case.
21. Docq (Presse Méd. Belge, 1907, lix, 797). Partial gastrectomy, with posterior trans-mesocolic gastro-jejunostomy. Recovered. Recent case.
22. Poncet and Leriche (Revue de Chir., 1908, i, 855) mention having operated on four patients with gastric tuberculosis. No details are recorded.
23. Tichoff (Cited by Bereznegovsky: Chirourgia, 1908, xxiii, 632; in Journal de Chir., 1908, I, 489). In 1908, pylorectomy (Billroth I) for tuberculoma. Recovered.

24, 25. Operations by Nordmann and Lipscher, mentioned by Bereznegovsky (Jour. de Chir., 1908, i, 489).

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Syphilis of the Stomach. It has been said that the stomach is affected in about one per cent. of syphilitic patients. Among 243 autopsies which showed unmistakable lesions of syphilis, Chiari found syphilitic lesions of the stomach in three cases. In 1898 Flexner was able to collect only fifteen authentic instances of gastric syphilis, including one of his own. During the last decade the attention of surgeons as well as physicians has been more particularly directed to the stomach, and a number of other observations have been published, there being now on record probably almost fifty cases of gastric syphilis. Since Flexner's article appeared cases have been recorded by Baylac and Chamayou, Bird, Einhorn, Hayem, Hoover, Jullien, Kirsch, Lafleur, Lenzmann, Morgan, Schmaler, Torres Barberá, Tuffier, and others.

As in the case of tuberculosis it is important to distinguish ordinary ulcers of the stomach occurring in syphilitic persons, from gastric lesions primarily due to the syphilitic virus. In determining the true nature of the lesion, the microscopical appearances are a surer test than is the result of specific treatment. There is very good reason to believe that anti-syphilitic treatment will favourably influence the course of non-specific gastric lesions in syphilitic subjects, by improving the general health; and therefore it should not be assumed that the gastric lesions are specific merely because a course of mercurials or iodides prescribed for a syphilitic patient is followed by subsidence of the gastric symptoms. Yet it must also be remembered that in the interpretation of histological appearances even professed pathologists are not always in accord, and that this is particularly the case with syphilitic as well as with cancerous lesions.

Syphilis affects the stomach either as a diffuse *infiltration*, invading especially the submucous tissues, or as a distinct tumor—a *syphiloma* or *gumma*. In either case the lesions are prone to ulcerate, as a result of the endarteritis and consequent interference with the nutrition of the overlying mucosa. In Flexner's patient, whose stomach was the seat of an ulcerated submucous gummatous infiltration, death occurred from perforative peritonitis. In other cases, stricture may result. More common as a cause of obstruction is the localized syphiloma.

Bird claims to have observed 12 cases of gastric syphiloma, the pylorus being the seat of the tumor in 11 of the patients.

Syphilitic gastritis, in which there may be no specific lesions of the stomach, is a fairly frequent accompaniment of the disease. It is often encountered in patients with hereditary syphilis. It is sometimes caused by anti-syphilitic treatment.

The **diagnosis** of gastric syphilis rests on three points: first, the history of syphilis in the individual patient; second, the resistance of the gastric symptoms to all ordinary remedies; and third, the rapid amelioration under specific treatment. But even though all three of these postulates be fulfilled, the gastric lesions may not be due to a local manifestation of the syphilitic virus; and even though one or more of these factors be wanting, the lesions of the stomach may yet be syphilitic. Fenwick writes: "These cases chiefly differ from the simple variety of the disease" (gastric ulcer) "in three particulars, the first of which is the extreme severity of the pain and vomiting, the second the infrequency of hemorrhage, and the third their obstinacy to ordinary treatment and their great tendency to relapse."

Operative treatment is demanded only when one of the gastric orifices is obstructed by a syphiloma which is unaffected by specific treatment. Morgan reported the case of a patient who had suffered for four years from anorexia, flatulence, thirst, and dilated stomach with pyloric obstruction; these symptoms were attended by loss of weight, progressive emaciation, and finally the developement of a palpable mass in the pyloric region. As syphilis was denied, a diagnosis of carcinoma was made; but the patient finally acknowledged having had a chancre, followed by secondary lesions, four years previously. Iodide of potash was administered, the symptoms were promptly relieved, and health was restored. Tuffier in 1899 did gastro-jejunostomy in a syphilitic negro, in whom the pylorus was obstructed by a large, firm, elastic tumor which disappeared four months after the operation. It is only rarely that excision is to be undertaken. If any operation is requisite to aid the mercurials and iodides, some palliative procedure is to be preferred: gastro-jejunostomy for pyloric stenosis, and gastrostomy for obstruction of the cardiac orifice. Of course if the tumor is possibly, but not certainly malignant, and is

operable, excision should be done. Bird and others lay much stress on the hepatic and peritoneal involvement as characteristic of syphilis; Bird considers of importance the presence of "bluish striæ following the course of the lymphatics, or of splotches of opaque bluish white on the serosa, or of starred cicatrices with strongly fibrous or even calcareous centers." Tuffier thinks it probable that those pyloric tumors which disappear rapidly—in a few weeks—after a palliative operation, are really cancerous, and that their disappearance is due merely to their ascent beneath the ribs owing to the evacuation of the stomach through the gastro-enterostomy. Schwartz said that this seemed to be the explanation in a patient of his, in whom the tumor, which disappeared in three or four weeks, was really cancerous, since, although the gastro-enterostomy was working well, secondary nodules had subsequently developed in the great omentum.

Unless there is very good reason to suspect a syphilitic origin for the gastric symptoms, the surgeon will best consult the interests of his patient by not delaying too long an operation which is clearly indicated, for the sake of trying the effect of anti-syphilitic remedies. He should bear in mind, moreover, that symptoms of gastric distress in a syphilitic patient are frequently caused by the ingestion of anti-syphilitic remedies; and should such a cause for the symptoms be probable, these remedies should be discontinued temporarily, or be administered hypodermatically or by inunction. On the other hand, should the syphilitic origin of the gastric lesions become manifest by operation or otherwise, no time should be lost in getting the patient under the influence of mercury and the iodides: such treatment will be an important adjuvant to any operation that shall have been performed.

Operations for syphilitic lesions of the stomach have been recorded by:

1. Baylac and Chamayou (Arch. Méd. de Toulouse, 1901, vii, 145). Exploratory laparotomy. Wound closed. Recovery under anti-syphilitic treatment.
2. Bird (Surg. Gyn. and Obst., 1907, iv, 635). Partial gastrectomy for supposed cancer of the pylorus. Eventual recovery.

3. Bird (Ibid., loc. cit.). Exploratory laparotomy. Wound closed. Recovery under anti-syphilitic treatment.
4. Bird (Ibid., loc. cit.). Exploratory gastrotomy. Recovery under anti-syphilitic treatment.
5. Hayem (Presse Méd., 1905, i, 105; Allg. Wien. med. Zeit., 1905, l, 383, 393. Case 3). Gastro-jejunostomy as a last resort for pyloric obstruction. Death.
6. Hayem (Ibid., loc. cit., Case 4). Partial gastrectomy for tumor thought to be cancer. Recovery.
7. Lafleur (Montreal Med. Jour., 1903, xxxii, 488). Exploratory gastrotomy by Armstrong; a piece of gastric wall removed for examination. Recovery.
8. Tuffier (Bull. et Mém. de la Soc. de Chir. de Paris, 1899, xxv, 837). Gastrectomy for pyloric obstruction. Recovery.

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Morgan: Amer. Med., 1906, xii, 123.
Schwartz: Bull. et Mém. Soc. Chir. Paris, 1899, xxv, 838.
Tuffier: Bull. et Mém. Soc. Chir. Paris, 1899, xxv, 837.

Phlegmonous Gastritis. Phlegmonous gastritis is a rare form of inflammation of the stomach, which has been recognized, according to Schnarrwyler, since 1656, when a case was first observed by P. Borel. It has been described under a multitude of names, which are given at length by Leith, and of which the most frequently employed are "submucous gastritis" and "suppurative linitis."

The disease is defined by Schnarrwyler as a "diffuse purulent inflammation of the stomach, which has its chief seat in the submucosa, but which may later produce a lymphy and finally purulent infiltration of the intermuscular connective tissue, and thus eventually reach the serosa; while on the other hand the overlying mucosa becomes infiltrated with pus cells and swollen."

Robson and Moynihan, in their work on Diseases of the Stomach, have gone into the pathology and symptoms in considerable detail, and little can be added to what they then wrote. They tabulated 85 cases of the disease, collected from various sources, including three original. Schnarrwyler, writing a couple of years later, accepted as authentic only 80 cases found in the literature, and added three which had been observed by himself. Robertson in 1907 reported two new cases (found at autopsy), and collected six cases from the literature since the publication of Schnarrwyler's monograph. According to the definition given above, only diffuse submucous inflammations should be included; but as there is no doubt that well localized phlegmons of the gastric wall are occasionally encountered, it seems scarcely worth while to make a separate classification for "phlegmon ventriculi," and we therefore agree with Robson and Moynihan, who describe phlegmonous gastritis as existing in two forms, the circumscribed and the diffuse.

Although there seems good reason to believe that the disease occasionally arises without any macroscopical lesion of the gastric mucosa, it is more frequently encountered as a complication of gastric ulcer, or a sequel to some operation on a stomach which is already the seat of catarrhal gastritis. The streptococci are the micro-organisms most often found; but staphylococci, colon bacilli, and even gas bacilli, have been recovered from the stomach in some instances.

Operations have proved the exciting cause in cases recorded by Schnarrwyler, Eiselsberg, Page, and others. In Schnarrwyler's patient an anterior gastro-jejunostomy had been done by Hildebrand for an inoperable mass obstructing the pylorus. Death followed in five days; and the autopsy showed that it was caused by a diffuse sero-purulent peritonitis arising in a purulent infiltration of the stomach walls, which had not been present at the time the operation was done. In Eiselsberg's patient death from phlegmonous gastritis followed six days after he did "gastro-enterostomia retrocolica anterior"; and in a patient operated on by Page, fatal phlegmonous gastritis followed the performance of gastrostomy for stricture of the œsophagus.

The clinical picture presented by a patient with diffuse phlegmonous gastritis is thus graphically summarized by Robson and Moynihan: It is that "of a patient acutely ill from some febrile disease, with irregular elevations of temperature, very feeble and rapid pulse, vomiting, constant pain in the abdomen, referred generally to the epigastrium, and slight tenderness on deep palpation. It is therefore," they proceed, "not a matter of surprise to learn that a positive diagnosis of phlegmonous gastritis has never been attempted."

The purulent collections in the submucosa are solitary or numerous; the abscesses vary in size from that of a millet seed to that of a man's fist; they may perforate into either the stomach or the abdominal cavity; and in either case are almost surely followed by death. Whether the disease be of the circumscribed or of the diffuse form, peritonitis without macroscopical perforation of the gastric wall will be the nearly inevitable result; and unless exploratory operation were to be undertaken on very indefinite symptoms, peritonitis will have developed before a diagnosis is made.

In the circumscribed form of the disease it would be possible to evacuate the abscess by operation; but little could be done for the diffuse phlegmonous inflammation. Possibly by isolating the stomach with sterile gauze and incising its walls down to the mucosa, or even by opening its cavity widely, a favorable issue might be anticipated, if the operation were done before general peritonitis super-

vened. Excision of the diseased stomach would be impossible in most cases; while formal gastrostomy or gastro-enterostomy, in our opinion, could not but add to the gravity of the disease. It is worth while to note that all recorded cases of the disease in which the diagnosis is positive have been found at autopsy, with the exception of Mikulicz's and Bovée's patients who were cured by operation; five patients recovered without operation, but in these the existence of phlegmonous gastritis was only inferred.

Operations on patients with phlegmonous gastritis have been performed by:

1. Leith (Edinburgh Hospital Reports, 1896, iv, 51). Patient presented symptoms of diffuse purulent peritonitis. A median hypogastric incision seemed to show that the inflammation was more acute in the right iliac fossa. A second incision was therefore made, and the appendix removed. It did not appear to be gravely diseased. The abdomen was irrigated, the wounds were closed, but the patient died in seven hours. Autopsy showed that the peritonitis arose from diffuse phlegmonous gastritis, and that the inflammation had probably spread from the stomach first to the right iliac fossa (as is frequently the case with patients with perforated duodenal ulcer), and had subsequently become generalized.
2. Lennander (Lengemann: Mitth. a. d. Grenzgeb. d. Med. u. Chir., 1902, ix, 762). Patient with diffuse epigastric peritonitis. The stomach seemed to be the original seat of the disease, and it was tamponaded. Death in 60 hours. Phlegmonous gastritis found at autopsy.
3. Mikulicz (Lengemann: Mitth. a. d. Grenzgeb. d. Med. u. Chir. 1902, ix, 762). Patient with symptoms of perforated gastric ulcer. Operation disclosed sero-purulent peritonitis around stomach, from a not well localized phlegmon of the gastric wall. No perforation found. Irrigation and drainage. Recovery.
4. Bovée (Trans. Southern Surg. and Gyn. Assoc., Dec., 1907, in Jour. Amer. Med. Assoc., 1908, i, 311). A case of circumscribed suppurative phlegmonous gastritis; recovery after gastrostomy.

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Mikulicz: Cited by Lengemann: Mitth. a. d. Grenzgeb. d. Med. u. Chir., 1902, ix, 762.
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Robertson: Jour. Amer. Med. Assoc., 1907, ii, 2143.
Schnarrwyler: Archiv f. Verdauungskrankh., 1906, xii, 116.

Volvulus of the Stomach. Volvulus of the stomach appears to have been observed in only thirteen cases. In three cases (Langerhans, Mazzotti, Saake), hour-glass contraction of the stomach seems to have acted as a predisposing cause, though it is doubtful whether in Saake's patient a true volvulus existed. In other cases no cause was demonstrated, but in some there was noted a marked lengthening of the gastric ligaments, and in Berg's second patient a tumor near the cardiac orifice may have excited undue gastric peristalsis. The symptoms are usually pain in the epigastrium, but without fever or evidence of acute peritonitis. If the cardia be occluded by a twist, there will be no vomiting, and introduction of the stomach tube will be difficult or impossible; if it be not occluded, vomiting will be persistent; and the absence of bile from the vomitus may be an indication that the pylorus is occluded. The symptoms are those of intestinal obstruction and the physical signs closely resemble those of acute dilatation of the stomach; indeed as the usual effect of the volvulus is to occlude both orifices, dilatation of the stomach naturally follows. As already remarked, it is very difficult or impossible to introduce a stomach tube; and this fact alone shows that something more than mere gastric dilatation exists.

The rotation may take place in any direction, though there are three more or less typical directions in which it usually occurs. These are (1) Around an antero-posterior axis, in which case the stomach rotates either "clockwise" or "contra-clockwise" as viewed from the front; (2) around a transverse axis in the frontal plane, in which case the stomach rotates as an advancing or as a retreating wheel, viewed from the front of the body; or (3) around a longitudinal axis in the sagittal plane (an axis more or less at right angles to the greater curvature), when the stomach revolves either clockwise or contra-clockwise when viewed from the head of the patient. The most frequently encountered form is volvulus around a transverse axis in the direction of a retreating wheel (Berg, 2 cases, Wiesinger, Dujon, Pendl, Borchardt, and Wilke each one case—seven cases in all). In every instance but Borchardt's patient, the transverse colon followed the stomach upward and backward, being found

between the stomach below and the liver and diaphragm above. In Dujon's patient the great omentum, except at the pylorus, and the gastro-splenic omentum were torn off from their gastric attachment by the volvulus. He found that he could not produce this form of volvulus in the normal cadaver, unless the gastro-splenic and great omenta were ruptured. In Borchardt's patient the transverse colon maintained its normal position, but the gastro-colic

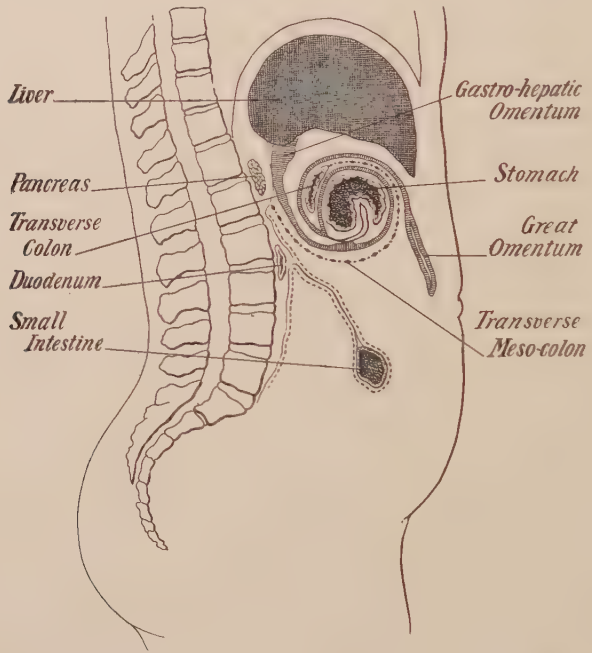

Fig. 29.—Wiesinger's Case of Volvulus of the Stomach.

omentum, which was very broad, was stretched to its utmost. In most cases the spleen has been more or less displaced; it may be ruptured; and either from it or the gastric vessels, profuse hemorrhage into the peritoneal cavity may occur.

Should the use of the stomach tube prove unavailing in relieving the distention, prompt operation is required. If the stomach is very tense, it should be evacuated by puncture or incision; when it

becomes flaccid, the puncture should be sutured, and the volvulus should then be reduced, if possible. The surgeon must remember the most frequent form of volvulus (around a transverse axis), for it is often impossible to determine by inspection how the viscera came to occupy the positions in which they are found. The transverse colon should be sought: it usually will be found close beneath the liver or diaphragm, and the spleen may be beneath the ensiform process, in the neighbourhood of the gall-bladder, or even in the pelvis. The posterior wall of the stomach usually presents, and has to be tapped; then as the evacuation proceeds the site of puncture may become inaccessible, and Berg was forced to suture his first puncture before the stomach was half empty, and to make another incision in that part of the gastric wall which then became more accessible. If reduction cannot be accomplished, the stomach should be drained, to prevent subsequent distention, and in the hope that spontaneous reduction may subsequently occur. If feasible this drainage is to be procured by means of gastro-jejunostomy; if this cannot be done, a gastrostomy will suffice. When reduction has been successfully accomplished, the stomach need not be drained, and it will not usually be requisite to seek to prevent a recurrence of the volvulus by gastropexy. In Berg's first patient no recurrence was noted, and he was reported as well more than ten years after the operation. (See Borchardt, loc. cit.)

Operations for gastric volvulus have been done by:

1. Berg, 1895. Stomach evacuated by trocar, and untwisted. Recovered, and well in 1906.
2. Berg, 1896. Volvulus untwisted by pulling one meter of small bowel and the transverse colon from a rent in gastro-hepatic omentum; then stomach itself followed them, and normal condition was restored. As there was an obstructing tumor near the cardiac orifice, the first stage of a gastrostomy was done, but as deglutition was not difficult during convalescence the stomach was never opened.
3. Borchardt, 1906. Gastrotomy; stomach evacuated and sutured. Volvulus could not be reduced. Profuse hemorrhage from rent in spleen. Gauze packs to left dome of diaphragm to check bleeding. Died in a few hours.

4. Delangre, 1907. Exploratory laparotomy: aspiration and reduction of stomach; gastropexy. Recovered, and well two months later.
5. Dujon, 1903. Exploratory laparotomy: inoperable condition found, and wound closed. Died next day.
6. Pendl, 1904. Stomach punctured and evacuated, and volvulus untwisted. Recovered.
7. Wiesinger, 1901. Stomach punctured and evacuated, and volvulus untwisted. Recovered.

CASES OF VOLVULUS OF THE STOMACH.

I. Around Antero-Posterior axis.
   (*a*) Clockwise—no cases.
   (*b*) Contra-clockwise:
      1. Streit (Amer. Jour. Med. Sc., 1906, i, 967).

II. Around Transverse Axis in Frontal Plane.
   (*a*) As an advancing wheel:
      1. Delangre (Revue de Chir., 1907, xxxvi, 603).
   (*b*) As a retreating wheel:
      1. Berg (Nord medicinskt Arkiv, Fest-Band, Stockholm, 1895, Fall 1; cited by Dujon: Gaz. Méd. de Paris, 1903, lxxiv, 173).
      2. Berg (Ibid., loc. cit.).
      3. Borchardt (Arbeit. a. d. chir. Klinik (Bergmann), Berlin, 1906, xviii, 104).
      4. Dujon (Gaz. Méd. de Paris, 1903, lxxiv, 109).
      5. Pendl (Wien. klin. Woch., 1904, xvii, 476).
      6. Wiesinger (Deutsch. med. Woch., 1901, xxvii, 83).
      7. Wilke (Münch. med. Woch., 1907, liv, 1012).

III. Around Longitudinal Axis in Sagittal Plane.
   (*a*) Clockwise when viewed from patient's head.
      1. Berti (Gaz. Med. Ital. Venete, Padova, 1866, ix, 139; cited by Dujon: Gaz. Méd. de Paris, 1903, lxxiv, 109).
   (*b*) Contra-clockwise when viewed from patient's head.
      1. Langerhans (Virchow's Arch. f. path. Anat., cited by Dujon: Gaz. Méd. de Paris, 1903, lxxiv, 175).
      2. Mazzotti (Rivista Clinica di Bologna, 1899, iv, 280; cited by Dujon: Gaz. Méd. de Paris, 1903, lxxiv, 175).
      3. Saake (Virchow's Arch. f. path. Anat., 1893, cxxxiv, 181).

Eventration of the Diaphragm.—(Eventratio Diaphragmatica.) This rare condition, which is sometimes confounded with diaphragmatic hernia, is defined by Sailer and Rhein as "an abnormally high position of the left half of the diaphragm, with dislocation upward of the abdominal viscera, particularly the stomach, on the left side; hypoplasia of the left lung, and displacement of the heart to the right." These authors, in reporting an original case, collect twelve other instances of this malformation, and it is from their valuable article that most of what follows has been abstracted. Arnsperger's patient brings the total of reported cases to 14.

As a rule, the **symptoms** closely resemble those of diaphragmatic hernia, which is more frequent on the left than on the right side; but there is in eventration of the diaphragm no history of sudden onset nor of trauma; in the immense majority of cases the condition is congenital, though Sailer and Rhein consider it possible that an acquired form may exist. Although, as has been stated, there is usually no history of a sudden onset, there may be exacerbations of the symptoms. These, if manifested clinically in any way, are apt to be characterized by dyspnœa and cardiac palpitations. The condition is seldom accurately diagnosticated until autopsy. During life the most prominent physical signs are dextrocardia and tympany in the lower left chest. The differential diagnosis from pneumothorax and diaphragmatic hernia is important; indeed, it is only its resemblance to the latter condition that renders it of interest surgically. In pneumothorax, some cause for the anomaly usually may be discovered, dating its developement; and the upper border of the tympanitic area does not move during respiration, whereas in eventration of the diaphragm this is a constant sign. By means of the stomach tube, distention of the stomach with air or liquid will demonstrate its position, and a skiagraphic examination may show that the diaphragm retains its normal level in pneumothorax, whereas in eventration of the diaphragm it is markedly elevated. Diaphragmatic hernia usually can be excluded by the history. In one case of eventration of the diaphragm studied by Widemann, a diagnosis of diaphragmatic hernia was made a year

later by Glaser. The patient, 48 years of age, had had four attacks of pleurisy. Profuse gastric hemorrhage ushered in the last attack, and the patient was then taken to the hospital. All the signs of diaphragmatic hernia were present, but the first skiagraph made showed that the left side of the diaphragm was abnormally high, and that the stomach was not above it. (Widemann.) "Later a transverse line below the clear area could be seen moving with the respiratory excursion, and a diagnosis was made of diaphragmatic hernia." (Glaser, quoted by Sailer and Rhein.) As the hæmatemesis was repeated, the hernia was thought to be incarcerated. At the operation (done by Körte) no hernia was found. The patient recovered, but died a year later from carcinoma of the tongue.

The **treatment** of patients with eventration of the diaphragm can only be prophylactic of complications.

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Sailer: Amer. Jour. Med. Sc., 1905, i, 688.
Widemann: Berlin. klin. Woch., 1901, xxxviii, 279.

Diaphragmatic Hernia.—Diaphragmatic hernia has been observed in probably more than 500 cases. Grosser in 1899 was able to find records of 433 cases. This form of hernia may be classified as congenital and acquired; but here, as in other hernias, a distinction must be made between hernias which are present at birth, and those which, though due to some congenital defect in the diaphragm, do not develope until some time after birth, occasionally not until late in life. Either form of hernia, moreover, may happen to be Intraperitoneal, Subpleural, Subdiaphragmatic, or even Intrapericardial as in the case recorded by Grenier de Cardenal. Probably the least usual form is the subdiaphragmatic, which is also known as "true diaphragmatic hernia." In this variety the diaphragm becomes pouched, and the muscular fibres, even if weak and indistinct, may nevertheless be traced throughout the walls of the hernial sac. Jaffé collected 13 cases of this variety, including one observed by himself. If the protrusion occurs through a defect in the diaphragm, whether congenital or acquired (by stabwound, gunshot wound, or traumatic rupture of the diaphragm), the sac may still be lined by peritoneum; but this is very unusual. The pleura also is usually absent over the hernia, the variety most frequently encountered being that in which the herniated viscera (stomach, colon, etc.) lie free in the pleural cavity—intrapleural hernia.

The hernia is much more often on the left than on the right side. Among 282 cases studied by Deitz, in 261 (93.5 per cent.) the hernia was on the left. The reason for the immunity of the right side has always been said to be the presence of the liver beneath the diaphragmatic vault, acting as a buffer, and materially strengthening the right half of the diaphragm. There are certain regions of the diaphragm in which hernia is more apt to occur than in others; these are not, as might be expected, the natural phrenic openings, such as the œsophageal and caval orifices. Hernia through these is rare. There is, however, a triangular area found between the costal and sternal attachments of the diaphragm, which is filled in only with areolar tissue, and where the abdominal and thoracic cavities are not separated by muscular fibres. This weak spot is sometimes the

seat of a hernia; but more often the protrusion occurs in the neighbourhood of the left leaflet of the central tendon of the diaphragm. In congenital hernia the defect is usually in the posterior half of the diaphragm, which is a later developement than the ingrowth from the ventral surface of the fœtus. In other cases the hernia is situated in the posterior part of the diaphragm, along the outer margin of the left crus, and beneath the internal arcuate ligament. The most frequently herniated viscera, according to Deitz, are the stomach, colon, omentum, small intestine, spleen, liver, duodenum, cæcum, and kidney—in the order named. The bladder, the rectum, and the female generative organs have never been found in a diaphragmatic hernia.

Most cases of diaphragmatic hernia are observed in the fœtus, or in infants stillborn, or dying very soon after birth. In Lacher's cases, the age was recorded in 204 instances, and of these no less than 80 (40 per cent.) were in infants less than one year old, or in the fœtus. A child so malformed from birth is very badly equipped for the struggle for existence, and is prone to succumb to intercurrent maladies, especially pulmonary affections. Sudden death from acute cardiac incompetency is a frequent termination, especially in adults. Indeed it has been said that diaphragmatic hernia should always be considered in deciding the cause of a sudden death.

Males are supposed to be more subject to this affection than are females, and Warren states that sailors, soldiers, slaters, and carpenters are especially prone.

Subjective **symptoms** are often wanting, the malformation being unexpectedly found at autopsy. In the newborn, cyanosis and dyspnœa are prominent; the left thorax does not expand normally; there is dextrocardia; and death usually occurs within a few hours. The adult patient may have suffered from mild indigestion, with borborygmi, and tympany after eating; and this condition may have continued for years without material discomfort; at any time, however, acute overdistention of the herniated stomach may cause sudden cardiac failure, perhaps death; or strangulation of the hernia may arise from a strain which forces a larger portion of the abdominal contents through the diaphragmatic opening. Great thirst is a

symptom on which stress is laid by many writers. The symptoms due to stabwounds or gunshot injuries of the diaphragm, with protrusion of the stomach or colon, are usually overshadowed by those due to the injuries to the abdominal viscera involved.

The **physical signs** of a diaphragmatic hernia are much more precise in theory than in practice. We know certain so-called pathognomonic signs, by means of which diaphragmatic hernia may be distinguished from pneumothorax and other conditions which it resembles more or less closely; but when practical application is made of the tests, it must be acknowledged that both physician and surgeon frequently remain undecided as to the true condition present. Among the 276 cases collected by Lacher in 1880, only seven were diagnosticated during life; and though our diagnostic acumen has greatly increased, in regard to abdominal diseases, during the last generation, still it must be confessed that even yet the diagnosis of diaphragmatic hernia is usually very difficult. The physical signs and tests employed are fully described in most textbooks on the practice of medicine, and need be outlined here very briefly: The lower chest on the affected side is tympanitic; the breath sounds are absent or very feeble and distant; vocal fremitus is lost; expansion is decreased; and the heart is dislocated away from the affected side—that is to say, there is usually dextrocardia. The same signs exist in pneumothorax; but in diaphragmatic hernia the diaphragm does not descend on deep inspiration, and causes which may produce pneumothorax may nearly always be absolutely excluded, while a history of sudden onset following severe strain (sometimes childbirth) or a crushing injury, or occurring some years after a stabwound of the thorax, is highly characteristic of diaphragmatic hernia. Inquiry as to trauma some months or even years previously is important, as in several cases such a history has revealed the predisposing cause of the hernia, and thus confirmed a diagnosis tentatively made from the symptoms alone. In such cases the defect in the diaphragm may be congenital, and the previous accident may have been the first cause of prolapse of abdominal viscera through the opening; but no symptoms may have been noted until the recent strain, which produced incarceration or strangulation.

Moreover, introduction of a stomach tube and distention of the stomach with air or liquid (preferably the latter) will very quickly change the physical signs in the case of diaphragmatic hernia, while in pneumothorax the thoracic tympany and other signs will not be affected. The succussion splash, so characteristic of pneumothorax, may also be elicited with great clearness in many cases of diaphragmatic hernia; but filling the stomach with fluid will have no effect on this phenomenon if due to pneumothorax, while it will be speedily abolished if it was caused by fluid in an air-containing stomach. Aspiration is to be condemned as a method of diagnosis, the dangers of consequent septic pleuritis or peritonitis being very great. The distinction between eventration of the diaphragm and diaphragmatic hernia has been referred to at page 257.

A further aid in the diagnosis of diaphragmatic hernia is the Roentgen ray. The level of the diaphragm may thus be detected; and by introducing bismuth emulsion or a stomach tube filled with mercury into the gastric cavity, its relation to the diaphragm may usually be determined.

Treatment. There is no question that in cases of diaphragmatic hernia suddenly developed, and of evident traumatic origin, immediate reduction by operative means offers the greatest prospect of recovery. In such cases, as in other irreducible hernias so acquired, the danger of strangulation is particularly great, and the injury may have produced lesions of the herniated organs (rupture, hemorrhage, etc.) which can be treated safely only by surgical means. According to Lenormant, among 33 cases of wounds of the diaphragm in which no operation was done, collected in 1893 by von Frey, there were 29 deaths; and among 21 unoperated cases analyzed in 1901 by de Font-Reaulx, there were 16 deaths, and 3 cases in which diaphragmatic hernia subsequently developed. On the other hand, Lenormant himself collected records of 31 patients with wounds of the diaphragm which were operated upon, and of these only 7 died. Although this comparison refers only to stab-wounds and gunshot injuries, the conditions in subcutaneous rupture and in cases of diaphragmatic hernia of sudden developement are so similar that the figures given are applicable also to

injuries in which no external wound exists. In cases where it seems probable that the hernia is of long duration, and due to a congenital defect in the diaphragm, delay in resorting to operation is justifiable; but if the signs of incarceration or obstruction arise, no further time should be lost—the hernia must be reduced by operative means before strangulation has made reduction useless by producing œdema, sloughing, and gangrene of the herniated viscera.

Guthrie was the first who proposed "to make an opening in the abdominal cavity, and to introduce the hand in order to withdraw the bowel from the hernial opening." Permann and Postempski proposed in 1889, independently of each other, the operation of thoracotomy, Permann advocating it for ordinary cases of diaphragmatic hernia, while Postempski urged it, and successfully employed it in several cases, for wounds of the diaphragm. The first operation (laparotomy) in a non-traumatic case appears to have been carried out in 1879 by Bardenheuer (the hernia not being discovered until postmortem examination), while Postempski in 1889 did the first operation (thoracotomy) for stab-wound. Naumann, in 1888, appears to have been the first to find the hernia at operation (laparotomy); he was, however, unable to reduce it. Surgeons are divided as to the route by which the rent in the diaphragm should be approached, many preferring laparotomy, but most are in favour of thoracotomy. Iselin has recently (1907) tabulated the results of 35 operations for diaphragmatic hernia, not the result of recent injuries,* but which became incarcerated or caused symptoms of obstruction; 27 patients died, a mortality rate of more than 77 per cent. To the cases collected by Iselin may be added the reports of eight other operations for diaphragmatic hernia, the details of which are given at p. 266. Adding these eight operations to the 35 previously collected by Iselin, we have a total of 43 operations, with 34 deaths and only 9 recoveries—a death-rate of over 79 per cent. But if from this reckoning we omit the 13 cases in which the diaphragmatic hernia was not found at operation, all of which terminated fatally, we have left a total of 30 completed operations, with 9 recoveries and 21 deaths, or a death-rate of 70 per cent. Among

* Walker's case, however, was one of recent injury.

these 30 patients, 25 were treated by laparotomy, with 18 deaths, a mortality of 72 per cent., while of the 5 patients treated by thoracotomy, only 3 died, a mortality of 60 per cent. As the number of cases involved is too small to draw any definite conclusions, the records of the operations for stab-wounds of the diaphragm should be compared, since in these cases the advantages of thoracotomy are very evident. (See page 312.)

In favour of thoracotomy is the fact that the lung is already collapsed and the heart displaced, so that even wide opening of the pleural cavity could not materially increase the danger on that score; the greater accessibliity of the diaphragmatic opening also would make us prefer thoracotomy. More important, however, than either of these factors, is the existence of negative pressure in the unopened pleura; the herniated viscera are thus held in the pleural cavity by suction, and reduction by traction from within the abdomen is difficult, if not impossible. Indeed, the only reason we can see for preferring the abdominal route would be the possibility of injury to some abdominal organs which could not be repaired from above. A study of the cases, however, in which operation has been done for diaphragmatic hernia, has convinced us that in the immense majority of cases thoracotomy should be the operation employed. The technique consists in opening the pleural cavity, reducing the hernia, repairing the defect in the diaphragm, and closing the primary incision. In many cases an intercostal incision, preferably in the eighth interspace, will give sufficient exposure if the ribs are forcibly drawn asunder by strong retractors. The flap operations of Postempski, Rydygier, and others are not necessary, and should therefore not be employed. If the simple intercostal incision does not give sufficient exposure, one or two ribs—those bordering on the primary incision—may be resected for a distance of four or five inches. More room than is thus obtained is seldom requisite. Should temporary resection of the chest wall be employed, Rydygier's operation is to be preferred to that of Postempski. Rydygier made an intercostal incision, enlarging the existing stabwound, and joined this at its posterior extremity by an incision made downward from it, practically at

right angles to the ribs. The ribs are then divided in the line of the second incision, and the osteoplastic flap thus formed is turned downward and forward, the elastic costal cartilages, which are not divided, acting as a hinge. In Postempski's operation the ribs are divided front and back, and the flap thus made is turned directly downward. In some instances the flap formed by Postempski's method has sloughed. The use of hot moist compresses of gauze, to isolate the operative field from the upper portion of the pleural cavity and the lung, is of great assistance, and lessens any symptoms which may arise from the operative pneumothorax. In cases of stabwound, or of traumatic hernia, great care should be taken to repair any injury of the stomach, colon, or other structures found in the pleural cavity. As such injuries are in the upper or posterior walls of the stomach, they are readily accessible by the transpleural route, but are very difficult of access or totally inaccessible by laparotomy. After all ruptures or perforations are repaired, the herniated organs are to be reduced, and the breach in the diaphragm sutured. If this be very large, the omentum may be attached to its margins, by sutures; but usually it has been possible to close it without the use of omentum. It is generally safer to drain the pleural cavity for a few days; immediate closure of the thoracic wound without drainage has usually resulted in widespread subcutaneous emphysema, or in the developement of hæmothorax or empyema. In Riegner's patient with stab wound of the diaphragm, the abdomen was opened after repairing the herniated organs and the diaphragm by thoracotomy; but as no abdominal lesion was found, the laparotomy wound was immediately closed. While it is certainly safer to explore the abdomen if there is a probability of further lesions, in most cases such good exposure has been obtained by means of thoracotomy that no secondary laparotomy has been employed.

If no diagnosis other than intestinal obstruction has been made, laparotomy will be the operation employed; but if reduction of the hernia prove difficult from below, the surgeon should not hesitate to create a pneumothorax by means of thoracotomy, as has been done by Dennis and others, to relieve the negative pressure within the pleural cavity.

OPERATIONS FOR DIAPHRAGMATIC HERNIA ADDITIONAL TO ISELIN'S TABLES.

(Deutsch. Zeit. f. Chir., 1907, lxxxviii, 190.)

I. Hernia found only at autopsy.

1. Whiting (cited by Kelly, Proc. Pathol. Soc. Phila., 1900, 256). Diagnosis: intestinal obstruction of 5 days duration. Exploratory laparotomy. Patient died on operating table before lesion could be determined.
2. Patel (Revue de Chir., 1908, i, 861). Vague gastric symptoms for two years; signs of intestinal obstruction for eight days. Exploratory laparotomy, with false anus in cæcum. Death in eight days. Diagnosis at autopsy.

II. Hernia found at operation.

(A) Laparotomy.

1. Dennis (St. Paul Med. Jour., 1905, vii, 736). Diagnosis: obstruction close to stomach. Impossible to reduce hernia by laparotomy, until, by resection of one rib, pleura was opened; negative pressure within thorax being thus overcome, hernia was easily reduced. Diaphragm not sutured, but defect walled off with gauze through thoracotomy wound. Abdomen closed. Recovered after empyema.
2. Gordon (Annals of Surgery, 1907, i, 680). Stabbed six years before. Diagnosis: intestinal obstruction. Hour-glass stomach found in thorax, reduced; gastroenterostomy. Diaphragm not sutured. Died in four days. At autopsy part of stomach was found to have again passed into thorax.
3. Mackenzie and Battle (Lancet, 1901, ii, 1582). Stabbed seven or eight years before. Diagnosis: intestinal obstruction. Hernia reduced by laparotomy; diaphragm not sutured. No drain. Died in three days.
4. McRae (Trans. South. Surg. and Gyn. Assoc., 1894, vii, 77). Stabbed eight months before. Stomach was detected beneath intercostal scar as tympanitic swelling. Diagnosis: strangulated diaphragmatic hernia. Operation five days after onset. Hernia reduced by laparotomy; all structures found gangrenous. Died in eight hours.

5. Mixter (Bost. Med. and Surg. Jour., 1900, cxlii, 301). Sudden onset after violent exertions. Diagnosis: intestinal obstruction. Hernia reduced by laparotomy. Gauze packs to diaphragm, on account of collapse of patient. Died in fourteen hours.

(B) Thoracotomy.

1. Freeman (Trans. Amer. Surg. Assoc., 1900, xviii, 255). Recent hernia from crush. Reduced and diaphragm sutured by thoracotomy. Died.

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CHAPTER XI.

MALIGNANT DISEASES OF THE STOMACH: CARCINOMA.

Cancer of the stomach is a disease of frequent occurrence. From 25 to 40 per cent. of all cancers in the body are primary in the stomach. Statistics (Bryant) show that in Baltimore there are over two hundred deaths annually from cancer; that in Boston there are over three hundred, in Philadelphia nearly five hundred, and in New York nearly nine hundred deaths every year from some form of cancer. Of these deaths, more than one-fourth, and perhaps almost a half, are directly due to cancer of the stomach. Fenwick (loc. cit., p. 81) states that over 13 per cent. of deaths due to diseases of the digestive organs are caused by carcinoma of the stomach. Dowd says that the United States Census Report for 1900 recorded 9000 deaths from cancer during that year; that 31 per cent. of fatal cancers were in the stomach; that probably (as we shall see later) many cancers of the liver and the abdomen were primarily gastric; and that many cases recorded as gastritis and allied diseases were really carcinomatous in nature.

Ætiology and Pathology.—The **cause** of cancer is unknown. That it is caused by some form of micro-organismal life is inferred by some pathologists; but beyond such an inference even the most enthusiastic pathologists will not go. Direct curative treatment is therefore at present impossible.

In studying cancer of the stomach both the predisposing and exciting causes of its existence must be considered, and especially is this true of the predisposing causes. As will be shown under the discussion of Treatment, the surgery of the future will probably deal directly with some of these predisposing causes.

Race. Carcinoma, whether of the stomach or other region of the body, is peculiarly an affection of the Caucasian race. According to Bainbridge, the black races seem to be almost immune, the

yellow races are more vulnerable, while the white races are most liable to its presence.

Sex has very little influence on the occurrence of the disease. Among 1303 cases, Fox observed 680 men and 623 women; in 2214 cases studied by Welch, 1233 were males, and 981 females. Fenwick, after quoting these figures, gives results of his own researches: among 3679 post mortem examinations of gastric cancer, 2162 were males, and 1517 females, a proportion of rather less than 6 to 4. But as Fenwick points out, it is to be remembered that men form a larger proportion of hospital patients and of the subjects of post-mortem examination than do women, so that even these figures probably exaggerate the relative frequency of gastric carcinoma in men.

Age. Cancer of the stomach occurs usually in patients between the ages of forty and seventy years (about 80 per cent. of all gastric carcinoma cases). It is rare below the age of twenty and over that of eighty years. Bernoulli reports three cases that came under his own observation in which there was carcinoma of the stomach or rectum in patients aged fifteen, seventeen, and eighteen years respectively. He also collected 50 cases from the literature in which carcinoma had been found in the young, 13 of them having the stomach as the site of the cancer. In one instance the cancer of the stomach was evidently congenital.

Trauma may determine the localization of carcinoma in the stomach. Ropke found trauma a direct cause of gastric carcinoma in 2 out of 79 cases observed. Lacerations of the mucosa, from acute distension of the stomach, have been suggested by Strassmann and others as the starting point of gastric ulcers and cancers. (See p. 70.)

Dyspepsia. There is no factor which of late years has attracted so much attention as a predisposing cause of gastric cancer as has long continued indigestion. A more intimate knowledge of these cases will probably show that much of the digestive disturbance is due to the presence of an ulcer or its sequels (cicatrices, stenosis of the pylorus, etc.). "Chronic gastric irritation" possibly would be a better term to use to denote this predisposing factor in the

ætiology of carcinoma of the stomach. Thus Mumford and Stone traced 60 patients who had been treated at the Massachusetts General Hospital for "chronic indigestion," and who subsequently died. Of these no less than half died of gastric carcinoma. These writers further made a study of 50 patients with gastric carcinoma and learned that in no less than 41 of the 50 patients there was "a history either of ulcer or of long-continued digestive disturbance, of which the exact nature could not be ascertained." Mayo in 1905 found a history of ulcer or other disease in 36 per cent. of his patients with cancer of the stomach, and detected clear evidence of cancer having developed on ulcer in 30 per cent. of the last forty pylorectomies and partial gastrectomies performed; in 1907 he reported that the clinical history of 69 patients with gastric cancer, and pathological examination of the specimens removed from them by gastrectomy, during 1905 and 1906, made it clear that in 54 per cent. the cancer had its origin in an ulcer. Moynihan (1906) noted a history of gastric ulcer or chronic indigestion in 27 out of 45 patients with cancer of the stomach (60 per cent.); while among 22 patients with gastric carcinoma so far advanced as to be operable only by gastro-enterostomy, no less than 16, or over 72 per cent., gave such a history. Jedlicka quotes Ssapesko as stating that among 100 cases of gastric carcinoma only 10 were found in which the cancer was not engrafted on a preceding ulcer. Hayem found that 21 out of 94 specimens of gastric carcinoma collected in his service during fifteen years evidently had originated as degenerated ulcers. Further statistics could no doubt be quoted; they would merely serve to emphasize the point on which we insist, that *chronic gastric dyspepsia is the chief predisposing cause of cancer of the stomach.*

We know that cancer of the stomach presents clinically two forms. In one, a patient past middle life, without having suffered previously from indigestion, suddenly loses appetite, especially for meats, grows progressively weaker and more emaciated, developes epigastric pain and possibly a palpable mass, becomes subject to vomiting spells every few days, which bring up a quantity of coffee-ground material, foul smelling and fermented, and quickly developes the cancerous cachexia. This is the classical picture of gastric

carcinoma, and it is still seen; but it is of rarity when compared with that other course of developement which we have begun to appreciate only in the last few years. Gastric carcinoma appears with sudden onset in not more than ten per cent. of cases. The second, and much more frequent course, is found in patients who have been life-long sufferers from dyspepsia. Medical treatment has at times given relief, but the indigestion recurs again and again. Appetite may be preserved, but digestion is torture; so abstemiousness becomes second nature. There may or there may not have been some period when gastric ulcer was suspected or actually diagnosticated. Usually there have been no very definite symptoms, and the patient has been treated for chronic gastritis. Finally these patients die; and at autopsy a wide-spreading epitheliomatous ulcer is found.

The **histological changes** by which simple ulcer becomes converted into carcinoma have been particularly investigated by the French pathologists. Although their theories are not unreservedly accepted by other writers, they seem to merit a short description in this place, especially as, when considered in this light, these changes may be regarded as in the nature of predisposing causes. Hayem described, a number of years ago, adenomata in the pyloric region, which he characterized as Brunnerian in type —that is to say, resembling the glands of Brunner, which are found in the duodenum, and which are distinguished from the gastric glands by their situation within the submucosa, the gastric glands, as is well known, never extending below the muscularis mucosæ. These adenomata of Brunnerian type, occurring in the pyloric region of the stomach, are clearly neoplastic in character, and are regarded by Hayem as an early stage of carcinomatous transformation. Ménétrier has more recently (1900) elaborated his earlier studies along the same lines. He studied microscopically 15 ulcers (11 gastric and 4 duodenal) in various stages of developement, but all in activity, the cicatrization which existed in some being incomplete. Of the 11 gastric ulcers, 4 showed no traces of adenomatous changes; 6 showed clear adenomatous changes; and 1 had progressed to the stage of actual carcin-

omatous transformation. Of the 4 duodenal ulcers, 3 were clearly adenomatous, and 1 had no trace of such change. It is to be noted that of the gastric ulcers (4 in number) which showed no adenomatous change, 3 were ulcers which had been arrested suddenly in the course of their developement (two patients having died suddenly of hemorrhage, and one of perforation)—so that they had not been so long subjected to irritation from the gastric contents; and the only duodenal ulcer which showed no adenomatous change was a *recent* ulcer in a tuberculous woman, not a long-standing chronic ulcer, as were all those which did show this change. Ménétrier sums up his theory of carcinomatous transformation in this way: First stage—this is purely inflammatory; there is a chronic gastritis, and the cells lining the glands lose their special and distinctive features (the histological picture is simplified); and the "acid" cells disappear. Second stage—adenomatous in character; the proliferating glands, deprived of their characteristic elements, become more contorted and convoluted; the cells increase in number; cysts form as the result of obstruction of the gland ducts by proliferation of their lining cells. Third stage—epitheliomatous in character; the cell groups break through the muscularis mucosæ, and finally are found lying free among the connective tissues of the gastric walls.

Exciting Causes.—Ewing elabourately discusses, in regard to carcinoma, the parasitic theory, the theory of cell autonomy, and the modern biological and chemical study. He "shuts the door" against any theory of a specific cancer parasite, nor will he concede that a malignant tumor requires a continuous irritant propagated by micro-organisms throughout its course. He claims that cell autonomy could account for the phenomenal growth of malignant tumors, although an external stimulus may be required, but not of necessity. He claims that the chief hope for the reduction of the mortality from cancer depends upon the earlier recognition of the so-called pre-cancerous stage of the disease and the elimination of some of the factors. Other pathologists, however, believe the parasitic theory will eventually explain the cause of cancer. Odier looks upon cancer as a constitutional rather than a local disease.

He recognizes as "*cancérogène*" a substance (the X-substance of Ehrlich) which is produced by the organism without cessation. According to his theory, all that is necessary to prevent the growth of cancer is to abolish this "*cancérogène*", which he proposes to accomplish by increasing the glycolytic ferment, as glycogen seems to be indispensable to the growth of the cancer.

Clinical Pathology.—Situation. Carcinoma of the stomach is found in the pyloric region in from 57 (Luton) to 65 per cent. (Fenwick) of cases. The following table from Fenwick shows the location of the growth in 1850 cases collected by him:

	Pylorus.	Lesser Curv.	Cardia.	Post. Wall.	Greater Curv.	Anterior Wall.	Fundus.	Whole or Greater Part.	Multiple Growths.
Cases	1072	214	183	94	52	41	29	111	54
Per cent. of whole No.	58	11.5	9.8	5	2.8	2.2	1.5	6	2.9

Fenwick concluded, from these figures, "that in 79.4 per cent., or in about four-fifths of all cases, carcinoma commences in the comparatively small strip of tissue which extends from one orifice to the other along the upper margin of the stomach, and that its percentage rapidly diminishes the further we proceed from the pyloric valve."

The frequency with which carcinoma is found in corresponding situations on the anterior and posterior walls of the stomach, extending down as a saddle from the lesser curvature, also bears a striking resemblance to the ulcers which occur in this position; in both cases the involvement of both walls is to be attributed rather to analogous causes, such as a like blood supply, than to any fancied infection from a growth on one wall producing a similar growth on the opposite.

Histological Structure. Microscopically, three types of gastric cancer are recognized: (1) A tumor composed of spheroidal cells like those normally lining the gastric tubules (spheroidal celled carcinoma); (2) a tumor composed of more or less columnar or cylindrical cells, similar to those normally lining the pyloric

glands (cylindrical celled or adeno-carcinoma); (3) a tumor whose chief characteristic is myxomatous degeneration of epithelial cells and stroma (colloid carcinoma), which may be the result of changes in either the spheroidal celled or the adenomatous carcinoma. Finally these tumors are described as scirrhus or medullary (encephaloid) according as they are rich or not in fibrous tissue as compared with the cellular elements present.

There does not appear to be sufficient material for it to be positively decided which variety of carcinoma occurs most frequently. Brinton's figures indicated that 72 per cent. of gastric carcinomata were of the scirrhous variety; but more recent statistics collected by Brinton's method tend to show that the medullary forms preponderate. When histological examination shall have been recorded in a larger number of cases, it may become possible to say whether the spheroidal celled or the cylindrical celled variety is the more frequent. Colloid carcinoma is of course the result of secondary change, and is oftentimes not to be detected except on microscopical examination. Fenwick studied 115 cases of gastric carcinoma microscopically, and found that 63.5 per cent. were described as spheroidal celled, 28.6 per cent. as cylindrical celled, and 7.8 per cent. as exhibiting signs of colloid degeneration.

Metastasis. Metastasis occurs early in carcinoma of the stomach, but for a reasonable time this metastasis is confined to the immediately adjacent lymph nodes. According to Mumford, in from 4 to 10 per cent. of those patients with the perigastric lymph nodes palpably enlarged, no carcinomatous invasion of these lymph nodes exists. The lymphatics of the stomach have already been discussed (p. 13). Our knowledge of these lymphatic areas is due almost entirely to the classical investigations of Cunéo; and Hartmann was the first to make practical applications of his teachings, in performing excision for gastric cancer. More recent observations have invalidated the conclusions of Cunéo in some anatomical details, but the practical lessons to be drawn from Cunéo's researches are in no way affected. The chief of these lessons is that carcinoma, beginning, as it usually does, along the lesser curvature close to the pylorus, invades first the lymph nodes lying along the

lesser curvature; and that this chain of lymph nodes is very quickly invaded even up to the coronary group of nodes surrounding the coronary artery close to the cardiac orifice. From this fact it is evident that radical operations for gastric cancer must remove practically the entire lesser curvature of the stomach. Moreover, as soon as the carcinoma is at all extensive, it is found that the lymph nodes in the gastro-colic omentum, for a variable distance away from the pylorus, are involved. Hence Hartmann's line for gastrectomy was made to pass from the coronary artery to a point nearly directly below it, on the greater curvature of the stomach. A third point of the greatest importance is that whereas the carcinomatous invasion extends rapidly and for an indefinite distance away from the pyloric region of the stomach, it invades the duodenum only rarely. The removal of the first inch of the duodenum will nearly invariably enable the surgeon to get safely beyond the limits of the malignant growth. It is a well-recognized fact that the palpable induration of the gastric cancer stops with the area of mucosa affected, but that in the submucosa the invasion will have advanced considerably further: hence the necessity of cutting wide of the indurated margins of the carcinoma. From Borrmann's studies of resected stomachs from the clinique of Mikulicz it is evident that these incisions must be made from 5 to 8 cm. (two to three and a half inches) away from the macroscopical tumor on the cardiac side of the growth, and from 1.5 to 2 cm. (one-half to three-fourths of an inch) from it on the intestinal side.

While Cunéo found that the presence of lymph nodes beneath the pylorus was very unusual, Jamieson and Dobson found them quite frequently present, thus confirming the observations of Lengemann, who noted their presence in 60 per cent. of the stomachs examined. But Cunéo's conclusion that the removal of these glands is rarely necessary, is paralleled by Jamieson's and Dobson's assertion that their removal would be extremely difficult, if not impossible, and that it probably is very rarely accomplished. And, while Cunéo thought that the pylorus and the whole of the lesser curvature drained into the lower coronary group of glands as they are named by Jamieson and Dobson, these writers found that in

not a few instances lymph channels may be traced which pass directly past these glands, and empty into the right supra-pancreatic glands lying along the trunk of the hepatic artery. The disheartening conclusion is reached by Jamieson and Dobson, as a result of their studies, that "except as a mere matter of chance no operation for gastric carcinoma can be a radical one when once malignant emboli have commenced to reach the lymphatic glands. The only reason," they add, "for removing as many of the diseased glands as possible, is the hope that once the primary growth and the majority of the glands have been removed, the remaining glands may be able to deal with, and, perhaps, destroy, the malignant elements they contain; of this process, however, we know little or nothing."

Apart from the lymph nodes, metastasis of gastric carcinoma occurs most frequently to the liver, which is affected in one-third of cases examined at autopsy. The malignant invasion occurs along the radicles of the portal vein. In scirrhous carcinoma, and in all forms which cause marked pyloric stenosis, invasion of the liver is unusual. The great omentum becomes invaded by cancerous nodules almost as frequently as the liver, but ascites is a rather unusual accompaniment. The lungs, the intestines, and other internal organs are as a rule invaded only very late in the disease. The left supraclavicular lymph nodes are sometimes affected in the last stages of gastric carcinoma, but it is worthy of note that these nodes frequently have been found enlarged, without being affected by any cancerous change which could be detected even by microscopical examination.

Extension by Contiguity. Gastric carcinoma is the most frequent cause of internal gastric fistula. Of 66 cases referred to by Lieblein and Hilgenreiner, in which a gastro-colic fistula was due to disease of the stomach, it was caused by carcinoma in 47. The gall bladder is much less often involved. In any case, it is not very unusual for a fistula thus formed to close again spontaneously before death, by the developement of further perigastric adhesions. The pancreas, the liver, and, very rarely, the spleen, may be invaded by direct extension of the growth. Perforation of the diaphragm,

and even the formation of a gastric cutaneous fistula, is sometimes observed. Fenwick refers to 22 instances of this last condition, 3 of which came under his own observation at autopsy. According to Lieblein and Hilgenreiner, cancer is a more frequent cause of gastric cutaneous fistula than is gastric ulcer. They collected 26 cases due to the former, and found only 17 caused by ulcer. The reader is referred to this valuable monograph for further statistics of gastric fistulæ. (See also p. 435.)

Perforation of gastric cancer into the free peritoneal cavity is very rare, existing in only 3 per cent. of the fatal cases studied by Fenwick. Sometimes a subacute perforation occurs, with the formation of a perigastric abscess; and this, by subsequent rupture, may cause death from peritonitis. Such a case, recorded by Dr. Ashhurst, has already been described in connection with Hour-glass Stomach. (See p. 189.)

Secondary gastric carcinoma is of little surgical interest. It is found in 6 or 7 per cent. of autopsies on patients with gastric cancer (Hale White; Fenwick), and is usually (73.6 per cent. according to Fenwick) due to direct extension from some neighbouring organ, such as the pancreas, transverse colon, gall-bladder, uterus (through omentum), œsophagus, etc.; less frequently (21 per cent.) it is secondary to cancer of the tongue, mouth, pharynx, upper œsophagus, etc., being then perhaps due, as suggested by Klebs, "to the detachment of particles of growth, which are swallowed, and subsequently become engrafted upon the gastric mucous membrane." (Fenwick.) Engelhorn calls attention to gastric carcinoma occurring simultaneously with, or secondary to, carcinoma of the ovary. He has studied 13 cases from Döderlein's clinique, and suggests the propriety of examining the patient for gastric carcinoma whenever malignant disease exists in the ovary. True metastases (from mammary gland, testicle, uterus, kidney, etc.) were found in 5 per cent. of Fenwick's cases, and are usually accompanied by metastatic invasion of the lungs, liver, etc. Hence surgical treatment is rarely required in secondary carcinoma of the stomach.

One patient who was operated on by Dr. Deaver by partial gastrectomy for carcinoma, returned 30 months later with a large pelvic

tumor. At the operation this was found to be a solid tumor of the ovary; it was thought to be carcinomatous; but after microscopical study Dr. A. O. J. Kelly pronounced it a *sarcoma*. There was no recurrence of carcinoma in the stomach or elsewhere.

Symptoms.—Although we have already (p. 270) pointed out the characteristics of the two main groups of cases in which cancer of the stomach is found, it is proper to dwell more at length upon certain individual symptoms. And in doing this, it is well to premise what is known to all who have anything to do with these patients, that early diagnosis of carcinoma of the stomach is so difficult as to be usually impossible; that is to say, an accurate, assured diagnosis, based on scientific reasons, and not a mere supposition nor a happy guess that the affection is malignant in nature. Even so distinguished an authority as Boas has recently come to the same melancholy conclusion.

The descriptions heretofore given in text books and monographs on diseases of the stomach are concerned almost wholly with the second, smaller group of cases, in which the symptoms were subacute or even acute in onset—this being the only group of cases of gastric cancer previously recognized. But as we have repeatedly pointed out, it is becoming more and more widely appreciated that this class forms only a small proportion, perhaps one-tenth, of all patients with gastric cancer; and that the far larger group will ultimately be found to consist of those patients who are sufferers from *chronic gastric dyspepsia*. These patients present the symptoms already noted in the section on gastric ulcer; and it is needless to reiterate those symptoms here. In the second group of patients, those who present what may be called the classical picture of cancer of the stomach, there are three symptoms which stand out with such distinctness as to be fairly characteristic; these are: pain, vomiting, and the presence of a tumor. But the pain and vomiting are not always present; and they vary greatly in their intensity, not only in different patients, but in the same patient at different times. Nor should the absence of a tumor be considered evidence that the disease is not cancer. The presence of a tumor, moreover, as already noted (p. 117), is frequently due to a purely inflammatory hyper-

plasia. So even in this group of cases where the clinical picture is outlined with reasonable distinctness, it is seen that diagnosis is no such easy matter.

The *pain* in cancer of the stomach differs from that of simple ulcer in several ways. It is not so sharp nor so localized a pain; it is not so invariably aroused by the ingestion of food; it is not so regularly relieved by abstinence; and it is seldom assuaged by a change of position or by rest. The pain of cancer of the stomach is more dull, aching, gnawing, and constant than is that of ulcer; it is more often of a tearing, shooting, or darting character, when perigastric adhesions are dense, or when neighbouring organs (liver, diaphragm, pancreas, etc.) have been invaded by the growth.

The *vomiting* of gastric cancer depends largely upon the location of the tumor. It usually will be absent when the growth infiltrates the gastric walls widely, without obstructing the pylorus. The evidences of cardiac obstruction (see p. 185), attended by great pain, hemorrhage, and beginning cachexia, are indicative of carcinoma in this situation. When pyloric obstruction is marked, vomiting becomes frequent. At an earlier stage any indiscretion in diet may set up an acute gastritis, which, instead of subsiding as have previous similar attacks, will, in the presence of cancer, persist in a subacute or chronic form. This fact alone is suggestive of beginning cancer. As dilatation of the stomach increases, the vomiting may again become less frequent, but at the same time the amount of vomited material will become more copious, and the evidences of stagnation and fermentation will be unmistakable. Close study of the vomitus, even in the early stages, will often reveal the presence of minute quantities of clotted blood; and at all stages of the disease, tests for *occult blood* as a rule will be positive. The stools should always be examined for occult blood. According to Kocher, Boas found this test positive in 107 out of 124 cases of gastric cancer. *Hæmatemesis* is rare; there is seldom so much blood lost as to deserve this term; or at least even if blood is lost in quantity, it usually is clotted before being vomited, and then presents the characteristic coffee-ground appearance.

Tumor is not an early sign in a pathological sense. It is, how-

ever, not unfrequently one of the first clinical evidences of the nature of the malady. Search for a tumor should be systematic and exhaustive. Palpation, with the patient erect, supine, and stooping; percussion, with and without distention of the stomach or colon, or both, with air; and finally complete emptying of the stomach—these should all be tried, in the endeavour to ascertain the existence of a tumor. The tumor moves with respiration, and if of the pylorus or greater curvature, often possesses some lateral mobility. By fixing the tumor at the end of inspiration, and holding it until expiration is complete, it can be felt to slide up beneath the fingers to its normal habitat in a characteristic manner. A tumor on the greater curvature becomes more evident when the stomach is distended; one on the lesser curvature disappears; one at the pylorus is pushed up beneath the liver if fixed by adhesions, while if free it descends towards the patient's right. In the presence of ascites it is of course necessary to draw off the fluid before satisfactory palpation is possible.

In addition to these three symptoms, there are three further changes constantly present in gastric cancer, which may be classed as **physical signs:** these are, *loss of weight; anæmia;* and *changes in the gastric secretion.* Loss of appetite, especially for meats, arising without apparent cause, has already been mentioned as a characteristic sign; and closely following this, and caused as well by the malignant growth itself, occurs *progressive loss of weight.* To render this apparent, the patient should be regularly weighed; it is not sufficient to estimate the loss of weight from the appearance of a man's face, or his visible emaciation; the weight should be recorded periodically, not oftener than twice a week, in pounds and ounces, care being taken to avoid any errors from changes in the weight of clothing. In the case of cancer it is found practically without exception that the loss of weight is progressive and constant, and that no form of dieting or forced feeding will check the loss permanently.

The *anæmia* of gastric cancer is that encountered in carcinoma elsewhere in the body. Leriche has recently made the significant statement that if cylindrical gastrectomy were done more often for

non-stenosing cancer, more cases of progressive pernicious anæmia would be cured. (See Regnault: "Anémie pernicieuse et cancer latent de l'estomac." Thèse de Lyon, 1905.) In gastric cancer both the red corpuscles and the hæmoglobin are reduced, but rarely to the extent that one would be led to expect from the cachexia present. The leukocyte count is as a rule constantly higher than normal, the polynuclears being increased at the expense of the lymphocytes. The absence of hyper-leukocytosis during digestion is considered by some nearly pathognomonic of cancer of the stomach.

The *gastric secretion* is very constantly altered in the later stages of carcinoma of this organ. Unfortunately the characteristic changes are not early enough in their occurrence to be of material value in reaching a diagnosis for surgical purposes. These changes are: constant absence or marked diminution of the hydrochloric acid, and the presence of lactic acid and other signs of fermentation. These changes are of confirmatory value if present, but if not present, no import need be attached to their absence. In carcinoma developing on ulcer, hydrochloric acid is apt to persist; and the fermentation signs may equally well be present in stagnation from benign disease. In normal stomachs the amount of hydrochloric acid gradually increases after the ingestion of food; in cancer, no matter how small in quantity at the first test after a meal, repeated tests show that the amount grows rapidly less, instead of increasing in quantity (Glutzinsky's test). Detection, by means of Esbach's reagent, of albumen (nucleo-albumen and mucin) in the washings from a fasting stomach, after excluding the possibility of albumen being present from previously ingested food, speaks in favour of carcinoma (Salomon's test). The value of these tests is emphasized by Kocher, as well as by Zirkelbach and Witte.

Diagnosis of carcinoma in its early stages by means of a *hæmolytic blood test,* has been attempted by Kelling, Crile, and others. Wideröe applied Kelling's test in 50 cases, using hen's blood, exclusively: 25 of these patients had cancer, and 25 suffered from other diseases. He found that 64 per cent. of the cancer cases gave positive results; 6 of the 9 patients in whom the test was negative

were already cachectic, this fact supporting Kelling's contention that the hæmolysis diminishes with advancing debility. In the patients not having cancer, the hæmolysis surpassed 30 per cent. in only three cases, and in 2 of these there was disease of the blood; in the patients with cancer, however, the degree of hæmolysis varied from 50 to 85 per cent. Paus, testing the blood of 90 patients, obtained a positive reaction in 65 per cent. of those in whom the course of the disease or operation confirmed the diagnosis of cancer. Crile found no hæmolysis in 107 normal individuals. Among 50 diseased persons, not suffering with cancer, the test was positive in only 4 (1 with hæmoglobinuria, 1 with eclampsia, 1 with hæmaturia, and 1 with undiagnosed gastric lesion), while among 50 carcinomatous patients 39 presented hæmolysis; and 13 out of 16 sarcomatous patients presented hæmolysis. In all patients with malignant disease who did not present hæmolysis, the disease was advanced.

Diagnosis.—It may now be asked: If the symptoms are so indefinite, the physical signs so misleading, and both of such late developement, how is a diagnosis to be reached in time for surgery to be of any avail? This is a pertinent question; and to find a conscientious answer is the sorry duty of the surgeon. It will not do to lay the onus of this task on the physician; if cancer of the stomach is a surgical disease, the surgeon should be able to reach a reasonably correct diagnosis. Boas diagnosed sixty cases of gastric cancer within three months of the appearance of the first symptoms of the disease. He found that of these only three (5 per cent.) could be treated by resection of the growth; that thirteen were suitable for gastro-enterostomy; and that two could only be explored. Of 127 cases diagnosed within six months of the appearance of first symptoms, Boas found that only eight (6.3 per cent.) were suitable subjects for resection. From this experience Boas came to the conclusion that the early diagnosis of gastric cancer is at present usually impossible; that the constant moan of surgery that patients are not sent early enough for operation, is not warranted by the facts; and that those patients who encounter the question of operability more than six months after the first onset of symptoms afford a greater

hope of radical cure than do the earlier cases. But Hoffmann, in Mikulicz's clinique, found that of 117 cases diagnosticated within three months of onset, twenty-four (20.8 per cent.) could be treated by resection; and of 193 cases whose first symptoms dated back six months to one year, he found fifty-eight (30.3 per cent.) could be treated by resection. This discrepancy between the surgical and medical statistics is not due to the fact that Mikulicz allowed wider limits to the indications for radical operation; but because the worst cases go to the physician and the more operable ones go directly to the surgeon. Moreover, the patients seen by medical men are either hospital out-patients, or those in private practice—the number is great, but the patients do not remain long under observation; they pass on to another clinique.

It has been true in the past, but it is now much less true, at least of progressive physicians, that they did not send the patients early enough to the surgeon. The surgeon should be called in consultation as soon as an anatomical cause for the gastric disease is recognized, and in obscure cases he should be consulted even before this stage of accuracy in diagnosis has been reached. Likewise, when gastric cases come directly to the surgeon, he is only too glad to have the opinion of his medical colleagues, and to avail himself of such aids as the clinical laboratory can afford. But he has been the first to recognize that, as all signs fail in dry weather, so the possibility of reaching an accurate diagnosis must be postponed in certain instances until the patient will be beyond the help of surgery. Under such circumstances, and when there is undoubtedly some actual anatomical lesion of the stomach, even though an exact pathological diagnosis of the lesion has not been reached, but because it is evident that only some form of surgical operation will be of any avail in curing the disease,—under these circumstances, we repeat, we believe exploratory operations should be undertaken. We do not advocate exploration as a therapeutic test; we do not say, do gastro-enterostomy for pain in the stomach and if the result is favourable conclude that the disease was gastric ulcer, and if the patient dies assert that death was clearly due to the cancerous cachexia; nor do we counsel exploration merely because it is easier for

the surgeon and possibly less distasteful to the patient than careful examination and repeated study of the disease by other means; and we do believe that in the vast majority of patients with gastric disorders a diagnosis of sufficient accuracy can be reached before operation is undertaken thoroughly to justify the operation when done. We are convinced, moreover, that if chronic and rebellious cases of indigestion were more promptly turned over to the surgeon, and if suitable operations were done on such patients, there would be fewer cases of carcinoma of the stomach observed by physicians. It seems to us that every case diagnosticated *certainly* as carcinoma of the stomach before operation is a disgrace to the attending physician, provided he has had the patient under treatment for more than a few weeks. In that space of time it is at present usually impossible to render absolute the diagnosis of a gastric carcinoma while still in the operable stage; but it is entirely possible, and we contend with all earnestness that it should be done, to reach within that time the conclusion that an anatomical basis for the symptoms exists, and that this can be removed only by operative means.

In recapitulation, then, it may be said that the presence of cancer should be suspected when chronic gastric catarrh exists without any discoverable cause (such as abuse of food, of alcohol, of drugs; circulatory disturbances of the heart or liver; or diseases, such as gall stones, gastric ulcer, etc., which would cause some definite lesions in the region of the stomach), especially if this chronic gastritis be in a patient over forty years of age, and if it be attended by loss of appetite for meats (Kocher). If a tumor exists, the diagnosis is less difficult; but the tumor must be distinguished from a distended gall bladder, from a growth of the colon, of the pancreas, etc. In obscure cases distension of the stomach with air should never be neglected; this may render a hidden tumor palpable, and the characteristic pyramidal shape of a pyloric growth (apex toward the duodenum and indistinct base toward the body of the stomach) can frequently be recognized (Kocher). Occult blood in the stomach contents and fæces is the most valuable of the laboratory findings. In non-malignant ulcerations of the stomach, rest in

bed with milk diet will cause the disappearance of occult blood. In cancer no treatment has any effect.

In cases where the stomach affection resists medical treatment, exploratory operation is indicated. This is not always satisfactory, nor is it always possible, even by the senses of touch and sight, to make a positive diagnosis of carcinoma. Fortunately, the benefit is generally given to the patient and the diseased portion of the stomach removed when practicable, on the supposition that malignancy is present. Many of the most experienced operators have been misled by the conditions present, the true condition of affairs not being realized until the removed part of the stomach was subjected to microscopical examination. If a distinct tumor is present, it can generally be recognized as carcinomatous by its irregular shape; by its "knotty" feel; by diffused induration into the surrounding structures. Before there is tumor formation of any moment, it is practically impossible to differentiate between the thickening and induration consequent upon inflammation and that due to malignancy. While it is true that the mortality following posterior gastro-jejunostomy in benign disease is lower than that following gastrectomy, it is always justifiable and, in the opinion of some surgeons, mandatory, to subject the patient to the latter risk rather than to the surely fatal results of an undisturbed malignant condition, if such be present. If there were involvement of the lymph glands with metastasis to any of the neighbouring viscera, the diagnosis of malignancy would be unquestioned; without these complications or extensions, in the absence of the more or less characteristic tumor formation, the diagnosis must be tentative until a final appeal can be made either to the microscope, if the affected portion of the stomach be removed, or to the extension of the disease if it be allowed to remain *in situ*. Even a microscopical diagnosis is occasionally in error. If the freezing microtome is used to facilitate diagnosis during an operation, the surgeon's duty of course is to do a radical operation, when possible, if the report from the pathologist is positive; but if negative, he must rely solely on the clinical diagnosis.

Prognosis.—Though medical means are powerless to cure cancer in any region of the body, yet no one would be so foolish as to

deny that in cases of inoperable tumors much may be accomplished to prolong life and to mitigate suffering. Tyson says he is quite sure that a great deal more can be done in this way than is commonly thought possible. The wide experience of Jacobi, so cautiously and conservatively expressed, in regard to the beneficial effect of methylene blue (methylthionin hydrochloride) in such patients, is a gratifying example of what may be done by medical science even for hopeless cases. But, as Bland Sutton said a number of years ago, as long as we are ignorant of the cause of cancer, so long must the only successful treatment be the extirpation of the growth.

It is sometimes questioned by physicians whether surgery can really accomplish more in prolonging life than can medical measures. It is sometimes doubted whether surgery can ever effect a cure. To answer these questions surgeons must show the ultimate results of their operations. They must trace their patients for a period of at least three years after operation, and report their actual condition at the end of that time. But before the duration of life and the prospect of ultimate cure after surgical operation are discussed, and even before a comparison is made with the expectation of life and the certainty of ultimate death from the disease which are necessary attendants upon purely medical treatment; before these interesting questions are discussed, we repeat, it is expedient to study the immediate dangers of the operations which surgeons are urging in the treatment of this disease.

The mortality and the ultimate results of operations for benign gastric disease have already been considered in detail (pp. 105, 108). The results of such operations, which may be considered in the light of preventative operations for cancer, should be compared with the following figures of operations undertaken for the cure of this disease.

PARTIAL GASTRECTOMY FOR CARCINOMA.

Operator and Reference.	Cases.	Deaths.	Mortality per cent.
Berg (cited in Jour. Amer. Med. Assoc., 1907, ii, 2048)	62	9	14.5
Braun (Creite: Deutsch. Zeit. f. Chir., 1907, lxxxvii, 275)	50	19	38.0
Crile (Ohio State Med. Jour., 1908, iv, 80)	40 (20)	7 (0)	17.5
Czerny (Kausch: Berl. klin. Woch., 1907, xliv, 509, 574)	62	19	30.0

PARTIAL GASTRECTOMY FOR CARCINOMA.—(*Continued*).

OPERATOR AND REFERENCE.	CASES.	DEATHS.	MORTALITY PER CENT.
Deaver (Records of German Hospital, Phila.)	14 (9)	3 (0)	21.42
Garre (Matti: Deutsch. Zeit. f. Chir., 1905, lxxvii, 99)	26	7	26.9
Goullioud (Faysse: Arch. Internat. de Chir. Gastro-Intest., 1908, ii, 28)	13	1	7.7
Hahn (Matti: Deutsch. Zeit. f. Chir., 1905, lxxvii, 99)	28	10	35.7
Hartmann (Matti: Deutsch. Zeit. f. Chir., 1905, lxxvii, 99)	22	7	31.8
Kocher (Corresp.-Bl. f. Schweizer Aerzte, 1907, xxxvii, 265)	122 (25)	30 (4)	24.5
Krönlein (Matti: Deutsch. Zeit. f Chir., 1905, lxxvii, 99)	50	14	28.0
Maydl (Paterson: Gastric Surgery, New York, 1906, p. 104)	25	4	16.0
Mayo (N. Y. State Jour. of Med., 1906, vi, 63)	81 (25)	12 (1)	14.15
Meyer (N. Y. State Jour. of Med., 1906, vi, 68)	5	1	20.0
Kappeler (Matti: Deutsch. Zeit. f. Chir., 1905, lxxvii, 99)	30	8	26.6
Mikulicz (Matti: Deutsch. Zeit. f. Chir., 1905, lxxvii, 99)	100	37	37.0
Monprofit (Arch. Prov. de Chir., 1906, xv, 26)	30 (15)	6 (0)	20.0
Moynihan (Trans. Clin. Soc. London, 1906, xxxix, 84)	7	1	14.28
Paterson (Gastric Surgery, New York, 1906, p. 104)	4	1	25.0
Poppert (Riese: Deutsch. med. Woch., 1908, xxxiv, 735)	32	6	18.8
Riese (Deutsche. med. Woch., 1908, xxxiv, 735)	24	7	29.1
Robson, Mayo (Kausch: Berl. klin. Woch., 1907, xliv, 509; 574)	--	--	16.0.
Roux (Matti: Deutsch. Zeit. f. Chir., 1905, lxxvii, 99)	39	13	33.33
Schœnborn (Riese: Deutsch. med. Woch., 1908, xxxiv, 735)	32	9	28.0
Vassalo (Semana Medica, 1906, xiii, 407)	17	1	5.88

Taking, then, the more favourable recent figures of Kocher (16 per cent.), of Mayo (4 per cent.), and of Monprofit (no deaths in the last 15 operations), which offset to a certain extent the rather ancient statistics of Mikulicz (1901), Hahn (1898), Krönlein, Roux, Hartmann, and others, we have a total of 747 partial gastrectomies, with 189 deaths, or a mortality of over 25 per cent., as the immediate result of operations for the radical cure of gastric carcinoma. This, it will be remembered, is to be contrasted with an immediate mortality of about 5 per cent. after operations for the prevention of this disease.

It will next be proper to determine what proportion of the three-fourths of patients who survive gastrectomy may reasonably hope to be ultimately and permanently cured of their disease. Let it not be forgotten that over 80 per cent. of patients surviving the prophylactic operation have been proved to be ultimately cured. Robson and Moynihan in 1904 studied the statistics bearing on this point from the cliniques of Krönlein and Mikulicz; Kausch has more recently (1907) tabulated the results of Czerny and Kocher. From all these sources it is evident that patients suffering with gastric carcinoma have, under medical treatment, an expectation of life of about twelve months from the beginning of the disease. Many writers put it at less. Not only is this the duration of life, but it should not be forgotten that at the end of that time the patients under medical treatment will *all be dead.* There will not be even one among those treated medically who at the conclusion of that period will have had up to that time no recurrence of a malignant tumor successfully removed by operation, and who may, therefore, still be considered as curable—as potentially cured. If, then, surgery can show any permanent cures, and if the average duration of life under surgical treatment is longer, or at least not less than that under medical treatment, the conclusion surely is justified that surgical intervention is best for these patients. The question, in fact, is not "Is operation a sure cure for gastric cancer?" but "Does anything else offer even the shadow of a chance?" Even if the surgeon is aware that one out of four patients, or four out of sixteen patients, on whom he operates for gastric cancer will surely die, he should not therefore hold his hand, and thereby condemn the whole series to certain death in about a twelve-month's time. If he could say with certainty to himself, "I have had three recoveries from gastrectomy; this is my fourth patient, and he is therefore sure to die from the operation"—under such circumstances, of course, no surgeon would be justified in operating. But this is not the way to argue from statistics; for this surgeon with equal justice might have said to himself in the beginning, "This is my first patient for gastrectomy; even though the three following patients should recover, this first one will surely die; I will therefore refuse to operate for fear of killing him." Statistics are a valuable guide to prognosis

for those who know how to use them; and no surgeon can justifiably undertake an operation which he is convinced will kill his patient; but by employing that most precious quality of mind known as judgement, and by selecting the patients who are suited for the operation in question, the skillful surgeon is enabled to save many lives otherwise doomed to destruction.

What, then, is the prognosis in regard to prolongation of life by operation? Moynihan studied the average duration of life in patients who underwent gastrectomy in the cliniques of Krönlein and Mikulicz; he found that from the beginning to the end of the disease it was as much as twenty-four to twenty-five months, or more than twice as long as the average duration of life without operation. Paterson's figures from collective statistics give the duration of life after operation (86 operations in all) as an average of nineteen months after total gastrectomy (17 patients), of twenty-two and a half months after subtotal gastrectomy (14 patients), and of just over two years after partial gastrectomy (55 patients). Kausch reported an average duration of life after operation of 18.3 months in Mikulicz's patients, of 18.7 months in Kocher's patients, and of 18 months in Krönlein's patients. It should be noted that Moynihan's figures refer to duration of life after the appearance of symptoms of gastric cancer, while Paterson's and Kausch's refer only to the duration of life after operation. With this allowance, it is seen that the figures agree very closely; and as they are gathered from very different sources (Moynihan's and Kausch's from the German cliniques, and Paterson's largely from British sources), each series serves to confirm the other. Now if these patients had not been operated on, the duration of life *from the beginning of the disease* (not from the date of operation) would have been at most one year, probably less. Thus, as we have elsewhere pointed out, not only is life considerably prolonged, but at the end of this period a number of patients are still living and in good health; whereas if no operation had been done, they would all of them have been dead before this time was reached.

Moreover, not only may the mere addition to the patient's life be of utmost importance from a social, commercial, or financial point of view, but death, when it does come, will attack the sufferer in a less

hideous form. The patient will not die of starvation, as he would have done had no operation been performed. And although it would be heartless in the surgeon to tell his patient, when urging operation, that although the chance of permanent cure is slight, it is nevertheless altogether likely that he will die of cancer of the liver, with its attendant cachexia, and not from progressive starvation—although, we repeat, to draw such a picture of the future for his unfortunate patient would be diabolically cold-blooded in the surgeon, yet we doubt not that many a patient, dying of the cancerous cachexia some two years after the operation, will daily bless the art of surgery which has so prolonged his life and mitigated his suffering during the gradual approach of death.

But, though the chances of permanent cure are slight, they are not altogether imaginary. Leriche quotes the reckoning of Petersen and Colmers that one-fifth of those who survive the resection will be permanently cured. According to Kausch, Makkas traced 92 of Mikulicz's patients who had been operated on before 1902. He found 27 of these (30 per cent. of those operated on) still in good health; of these 17 were well more than 3 years after operation—which number represented 14.3 per cent. of the whole number operated on, and 23.9 per cent. of those who recovered after operation. Petersen and Colmers traced 18 patients from Czerny's clinique, and found that 6 were alive and well three years or more after operation—being 20 per cent. of the whole number operated on, and 33 per cent. of those who survived operation. Of 31 patients who recovered after gastrectomy in Braun's clinique 21 died of recurrence soon after; 3 patients lived respectively 20 months, 55 months, and 22 months after operation, and died of intercurrent disease, without recurrence; one patient was well more than 14 years after the operation; one was alive with recurrence one year after the operation; and the remaining 5 patients had been operated on too recently to be counted. In other words, of 26 patients from Braun's clinique that are available for estimating the ultimate results of gastrectomy, two patients certainly, and possibly four (15.4 per cent. of those who survived), can be counted as having been ultimately cured.

END RESULTS OF GASTRECTOMY FOR CARCINOMA.

Operator.	Cases without Recurrence after Three Years.		
	No. of Patients.	Per Cent. of Whole No. of Operations.	Per Cent. of Those Who Survived Operation.
Braun (cited by Creite)	2	..	6.5
British Surgeons (cited by Paterson)	33	..	38.3
Czerny (cited by Kausch)	6	20.0	33.0
Kocher (Corr.-Bl. f. Schw. Aerzte, 1907, xxxvii, 265)	18	19.3	26.0
Krönlein (cited by Kausch)	2	7.0	10.0
Mikulicz (cited by Kausch)	17	14.3	24.0
Robson (cited by Kausch)	..	14.0	..

In 1906 Paterson collected, mainly from British sources, the end results of 79 cases of gastrectomy (seven others, who also recovered, could not be traced); 46 patients (58.4 per cent. of those traced) dying of recurrence within three years, and 33 patients (41.6 per cent. of those traced) being alive and well at the end of three years or more after the operation. No less than 12 patients (15 per cent. of those traced) were in perfect health more than five years after the operation, some being in good health at periods varying from six to fourteen years after operation.

PATERSON'S STATISTICS OF END RESULTS OF GASTRECTOMY.

Nature of Operation.	Recovered.	Traced.	Died Since Operation.	Still Living and Well: Three Years After Operation.	Still Living and Well: Five Years After Operation.
Total gastrectomy	17	14	5	6	3
Subtotal gastrectomy	14	12	6	3	3
Partial gastrectomy	55	53	35	12	6
Total	86	79	46	21	12

Well three years after operation, 33, or 38.3 per cent. of recoveries.
Well five years after operation, 12, or 14 per cent. of recoveries.

Leriche still more recently has collected records of 94 patients treated by gastrectomy, who were traced and found in good health three or more years after operation; of these no less than 34 had been traced for from five to ten years after operation, and 6 for more than ten years. Kocher (1907) reports 10 of his patients (about 9 per cent. of those operated on) in good health more than four years after operation. Of Robson's patients, 14 per cent. were without evidence of gastric disease four years after operation. Of 130 gastrectomies done

by Mikulicz and his associates, which were analyzed by Makkas, a radical cure was reckoned in 18.4 per cent.; only 5 patients who survived the three year limit died later of recurrence. Among the 94 cases traced more than three years by Leriche, only 5 had recurrences after this space of time, and only two of these recurrences were after the five year limit. Though recurrence is thus seen to be rare after the three year limit it is extremely unusual after four years, and nearly unknown when five years have elapsed.

Possibly still further statistics might be quoted; but those already given are sufficient to show that *we may expect, at present, about* 10 *or* 15 *per cent. of patients treated by gastrectomy to be permanently cured without liability of recurrence.*

There is still another question of interest in regard to prognosis. That is the ratio of operable cases to the whole number of patients seen. The following table, compiled from Kausch (1907), Creite (1907), and Moynihan (1906), gives the total number of cases under observation; the total number of operations, with the relation of these to the whole number of patients; and the number of radical operations done, with the relation of these to the whole number of patients.

RATIO OF OPERABLE CASES TO WHOLE NUMBER OF PATIENTS.

Author.	Total Cases.	Whole No. of Ops. Including Explorations.	Ratio to Whole No. of Patients.	No. of Resections.	Ratio to Whole No. of Patients.
			Per Cent.		Per Cent.
Boas.....	234	48	20.5	11	4.7
Braun.....	241 (of whom 30 refused op.) = 211.	211	87.5 100.0	50	20.7 23.7
Körte.....	126	115	91.0	38	30.0
Krönlein...	264	197	75.0	50	19.0
Mikulicz...	665 (of whom 59 refused op.) = 606.	458	69.0 75.0	164	24.7 27.0
Moynihan..	70	59	84.3	10	14.3

What shall the surgeon do with those patients in whom the disease is so far advanced as to forbid a radical operation? In other words, Do palliative operations prolong life and add to the patient's com-

fort? Until operation is more frequently undertaken in the very early stages of the malady, **gastro-jejunostomy** must still be the operation most often adopted. It has been rare in our experience, as we think also in that of other surgeons, for a patient in whom cancer has been certainly diagnosticated before operation to present conditions admitting of gastrectomy. The operations of gastrectomy in our own hands have been on patients in whom the existence of malignant disease was merely suspected, but not certainly known, before the abdomen was opened. A palpable tumor felt before operation will naturally suggest cancer; but the case reports already referred to (see p. 117), in which such masses have been known to disappear after gastro-enterostomy, prove that all palpable tumors are not carcinomatous in nature. As Dr. Deaver has urged elsewhere, it is in this class of patients that exploratory laparotomy finds its most legitimate field. The statistics from the cliniques of Krönlein and Mikulicz, studied at length by Moynihan, show that patients who had undergone an exploratory laparotomy in which no further operative treatment was possible, actually lived longer than did those whose disease was so far advanced as to make even an exploration unjustifiable, or those who entirely refused an operation of any kind. In very many operations, moreover, which are commenced as explorations merely, it is found possible either to remove the growth, or at least to perform a palliative operation which will materially prolong life and relieve suffering. This, after all, and not the production of statistics, is the end and object of surgery.

Gastro-jejunostomy for carcinoma is naturally attended by a larger mortality than are similar operations for benign disease. The reported figures may be seen in the annexed table.

GASTRO-JEJUNOSTOMY FOR CARCINOMA.

Author and Reference.	Cases.	Deaths.	Mortality Per cent.
Berg	103	22	21.3
Deaver	31	10	32.25
Krause	36	12	33
Krönlein	74	18	24.3
Mikulicz	143	48	33.3
Monprofit	119	52	43.7
Moynihan	35	5	14.3
Paterson	7	1	14.3
Schloffer	66 (29)	14 (2)	21 (7)

The average duration of life after gastro-jejunostomy is almost certainly longer than when no operation has been done; but so far as we have been able to ascertain, the details thus far have been published in too few cases for very positive conclusions to be drawn. Moynihan traced 26 out of 30 patients who recovered after gastro-jejunostomy for cancer; six patients were still alive, one after thirteen months, and five less than twelve months since the operation. Of the 20 patients who had died, the shortest duration of life after operation was fourteen weeks; while two patients had lived more than two years. In Krönlein's patients who recovered from gastro-jejunostomy and were traced (54 in number), the average duration of life after operation was 193 days (over six months), and in Mikulicz's patients it was 6.4 months—or in each series about 3 months longer than if no operation had been employed. Moynihan, however, notes that if in this reckoning the immediately fatal cases are included, the average duration of life is slightly less than if no operation had been employed. However, the statistics of Mikulicz were compiled in 1901, and those of Krönlein in 1902; and it is but reasonable to suppose that since that time the results of gastro-jejunostomy for carcinoma have kept pace with the improvement in other departments of gastric surgery.

It appears from these statistics that in the hands of experienced abdominal surgeons the immediate mortality from gastro-jejunostomy in patients with cancer of the stomach is as high as, and in some instances even higher than that of partial gastrectomy for the same disease. But even if these statistics represent correctly the practice of the present, which is a little doubtful, it is not probable that this difference in the mortality of gastrectomy and gastro-jejunostomy for cancer is due to any inherent qualities of the respective operations; it seems rather attributable to the fact that gastro-jejunostomy has been and is still employed in patients already nearly dead from starvation and cachexia, with the forlorn hope of relieving their discomfort during their remaining days on earth. On the other hand, surgeons have been fearful of employing so extensive an operation as even partial gastrectomy in any but carefully selected patients. We believe that, other things being equal, gastrectomy is the more serious operation

of the two; and were it to be used as indiscriminately as gastro-jejunostomy has been, the relative mortality rates would appear in true proportion. Oversight of this fact seems to give some basis for the enthusiasm with which Robson and Moynihan suggest the employment of gastrectomy as a palliative operation even in cases where it is manifestly impossible to remove the entire disease. They speak as follows of the results of gastro-jejunostomy in cases of pyloric obstruction from cancer: "There can be no doubt that in such cases gastro-enterostomy is productive of the most remarkable benefit to the health and well-being of the patient. The weight increases, the appetite and the power of gratifying it return, and vomiting, often the most distressing and unceasing symptom, stops at once. But there can also be no doubt that in some instances, when the growth does not actually obstruct by its bulk the onward passage of food, a decided benefit results from the operation." But they say later, "The question may arise as to whether gastrectomy should not be performed deliberately as a palliative operation in cases where an early secondary deposit can be seen in the liver, or inaccessible or irremovable glands be found in the pancreas, or along the aorta and vena cava. If we take into account the following advantages of gastrectomy as compared with gastro-enterostomy—that in the most competent hands its mortality is not greater, but is even less, than the mortality of gastro-enterostomy; that a prolongation of life for ten months longer than the period given by gastro-enterostomy is the rule; that the comfort, the general health, appetite, and well-being of the patient are all emphatically better; and, finally, that the patient has always a chance, even though it is of the slenderest, of a complete recovery from his disease—if we take all these into our consideration, there can be no doubt that the operation of choice will always be gastrectomy." In spite of this partiality of these experienced surgeons, it seems to us that gastrectomy is best reserved for those cases in which it seems likely that it will be a curative operation. Surely if employed when secondary deposits exist in the liver, or where there are inaccessible or irremovable, but nevertheless surely carcinomatous lymph nodes,—surely in such cases there can be not even the

slenderest chance of a complete recovery from the disease after gastrectomy.

Finally, it is of interest in this connection to recall the researches of Katzenstein, as the result of which he suggested that the arrest of carcinomatous growths sometimes observed after gastro-jejunostomy might be due to the local action of the trypsin of the pancreatic juice, freely admitted to the stomach after the usual lateral anastomosis employed in this operation.

Prognosis after Gastrostomy and Jejunostomy. Still other palliative operations may be employed: gastrostomy in patients with carcinoma of the cardiac orifice, and jejunostomy where the stomach is too extensively diseased for the performance of gastro-jejunostomy. Mikulicz observed 46 patients with cancer of the cardia. Gastrostomy was done in 27 (58.7 per cent.) of these. Jejunostomy was employed in 12 cases. Moynihan employed gastrostomy in 5 patients, with no immediate mortality. One patient lived 17 months. Of three patients treated by jejunostomy, none died as the result of the operation, and one survived as long as 11 weeks.

Among 241 patients with cancer of the stomach, of whom 211 were operated on, Braun employed gastrostomy twice, and jejunostomy twice; the results are not stated. Maydl, according to Riche, reported in 1903, 27 jejunostomies for cancer, with 5 deaths, and only 1 death among the last five operations—a total mortality of 18.5 per cent. He compares this mortality with that following gastro-jejunostomy for carcinoma; but as Riche points out, Maydl advocated jejunostomy in cases where others would do gastro-jejunostomy, and did not reserve it for patients who were nearly moribund, as it is the custom of most surgeons to do.

Duodenostomy (above the bile papilla) has been employed successfully by Hartmann, and he advocates it as in every way superior to jejunostomy. We have had no experience with it.

It is our opinion that such palliative operations as these are very rarely indicated. It is very unusual, as Dawson has recently reminded us, for thirst to be an annoying symptom of carcinoma of the œsophagus or of the cardiac orifice of the stomach; and we consider his strong condemnation of such meddlesome surgery fully justified

by the trend of thought today. So long as patients with inoperable internal carcinoma are not starving to death, it is the part of wisdom to refrain from palliative and useless operations.

Treatment.—Having pointed out in the section on Prognosis, the expectation of life and the hope of radical cure which operative treatment offers to patients with carcinoma of the stomach, it next becomes necessary to decide upon the special type of operation to be adopted in specific cases of the disease.

The terminology of gastric surgery is not entirely uniform throughout the surgical world. The terms as used in this volume are defined in the chapter on the Technique of Operations on the Stomach (Chapter XIV), and to that the reader is referred for detailed descriptions.

Total gastrectomy will very rarely be advisable. Such extensive invasion of the gastric wall as to make this operation requisite will usually be found to be accompanied by so many perigastric adhesions or by such obvious metastases, as to render useless any but a palliative operation. Though successful in a sufficiently large number of cases to remove the procedure from the realm of mere surgical experiment, it is not an operation which any surgeon should feel himself competent to undertake, save one who has been thoroughly trained in gastro-intestinal surgery.

Subtotal gastrectomy is more difficult than partial gastrectomy only where adhesions abound. If there are extensive adhesions to the pancreas, any form of gastrectomy must usually be inadvisable. Although in a few cases portions of the pancreas have been excised in one mass with the stomach, yet the danger from infection, and from the digestive action of the pancreatic juice is so great, that the surgeon is rarely justified in exposing his patient to the greater risk, especially as freedom from recurrence in these cases is not to be anticipated. The raw surface of the pancreas usually must be covered in with gauze packs, and the patient's convalescence is thus much more delayed than when the abdominal incision can be completely closed. Yet Childe successfully excised a layer of pancreatic tissue in one piece with the stomach and the transverse colon, and Sauvé has just published a paper advocating partial pancreatectomy when necessary.

Excision of the transverse colon *en masse* with the cancerous

stomach appears to have been employed in no less than 14 cases, with 9 recoveries and 5 deaths; the mortality (36.7 per cent.) is thus considerably less than might have been expected from so extensive an operation. Kocher has done this operation in five patients, two of them recovering, and death in one of the fatal cases being due not to the operation itself, but to pneumonia five weeks after the operation. It is an operation which is logically correct, when the transverse colon is itself invaded, but not to such an extent as to prevent entire removal of the malignant growth; and even in cases where the blood supply of the colon is jeopardized by the radical removal of the gastric disease (as in Childe's patient, referred to above, and in Krause's patient), even though the colon be not itself invaded by carcinoma, it is better successfully to remove an organ whose blood supply is destroyed, than to expose the patient to almost certain death from gangrene of the colon. In a few instances (Massmann, Ross, and others), the middle colic artery has been unwittingly ligated in doing a gastrectomy, and the patients have died from peritonitis due to the ensuing gangrene of the transverse colon.

RESECTION *EN MASSE* OF STOMACH AND TRANSVERSE COLON.

	Cases.	Deaths.
1. Childe. Patient in good health four months later	1	0
2. Creite. Patient died over two years later, without local recurrence, but with metastatic growths in the liver	1	0
3. Fischer. In 1888 excised cancer of anterior gastric wall, with transverse colon and overlying abdominal wall. Lived five months	1	0
4. Gallet. In 1899 did excision of whole stomach and whole transverse colon; patient in good health six months later	1	0
5. Hentschel and Reichel. In 1894 did resection of gastric wall and excision of transverse colon for carcinoma	1	1
6. Kocher. One fatal case due to pneumonia five weeks after operation	5	3
7. Krause. Ligation of middle colic artery requisite for completion of gastrectomy. Transverse colon found blue and cold at end of operation. On account of collapse of patient the colon was isolated with gauze packs, and resection postponed to next day. Patient in good health five months later	1	0
8. McCormick and Welsh. Operation for sarcoma of stomach. See p. 306.	1	0
9 Moynihan	2	1
	14	5

Partial gastrectomy is the operation of choice for the radical cure of gastric carcinoma. As already remarked the differences between it and subtotal gastrectomy are slight, in regard to difficulty of performance, immediate mortality, or operative technique. Subtotal gastrectomy is necessitated by a more extensive invasion of the neoplasm toward the fundus and along the greater curvature. The question of most interest in this connection, in regard to partial gastrectomy, is the method to be adopted for restoring the continuity of the gastro-intestinal canal. These methods are Billroth's first method; Billroth's second method; Kocher's method; and posterior trans-mesocolic gastro-jejunostomy—which latter procedure includes several subvarieties, as the long loop method (with or without entero-anastomosis), the no loop method, the Y-method, etc. Full descriptions of these various methods will be found in Chapter XIV.

Billroth's first method is nearly universally condemned. According to Paterson leakage at the "fatal angle" occurred in 23 per cent. of the cases he collected. Kocher quotes Guinard's collective statistics, of 148 gastrectomies by Billroth I, with a mortality of 35.3 per cent.

Billroth's second method (anterior gastro-jejunostomy), though inferior in our judgement to an operation completed by a posterior trans-mesocolic gastro-jejunostomy, is more widely applicable than the latter, especially in cases of subtotal gastrectomy, when the cardiac pouch is small. Unless it is contra-indicated, our preference is for the restoration of the gastro-intestinal canal by posterior trans-mesocolic gastro-jejunostomy, by the "no-loop" method. Difficulty of performance, as after subtotal gastrectomy, is the chief, indeed almost the only valid, contra-indication.

Kocher's method is of course strenuously supported by its author. He quotes Guinard's collective statistics of 64 operations by this method, with a mortality of 15.6 per cent. In the hands of Kocher and his associates this operation has been employed 92 times, with 14 deaths, a general mortality of 15.2 per cent. (12 deaths among the first 71 operations, or a mortality of 16.9 per cent.; and 2 deaths among the last 21 operations, a mortality of only 9.5 per cent.). Kocher further calls attention to the fact that all but three of the patients

permanently cured were operated on by this method; of these three, one patient was operated on by Billroth's first method; and in two patients the operation was circular (cylindrical) gastrectomy.

The operations of **cylindrical gastrectomy** and of **gastric resection** are very rarely indicated in cases of malignant disease. In carcinoma involving only the median portion of the stomach, the former may sometimes be available, but the rule enunciated by Leriche, himself one of the chief advocates of cylindrical gastrectomy, should be strictly enforced—namely, that cylindrical gastrectomy is *absolutely contraindicated* if there are enlarged glands in the gastro-hepatic omentum; since under these conditions it is imperative for the surgeon to remove the entire lesser curvature.

Gastric resection is suitable only for tumors confined to the anterior or the posterior wall of the stomach, and involving neither curvature; or for those confined to the greater curvature alone, at the fundus. How extremely rare such growths are, is recognized by all; and even should it seem possible to adopt this operation, the execution of a typical partial or subtotal gastrectomy would not only prove easier, in most cases, but would offer a greater chance of ultimate cure.

Gastrostomy is applicable only to cancer of the cardiac orifice or of the œsophagus. We think it should seldom or never be employed; certainly not in the case of patients who can still swallow liquids.

Jejunostomy or **Duodenostomy** may occasionally be adopted in cases of diffuse infiltration of the gastric walls not admitting of gastro-jejunostomy. In employing either gastrostomy or jejunostomy, the precarious state of the patient must be kept in mind; it is best for the surgeon to know before beginning the operation just what he intends to do, and then to do it without any unnecessary intra-abdominal explorations. By heeding this advice, and by adopting these operations as soon as a diagnosis is made, instead of waiting until the patient has one foot already in the grave, the surgeon may expect his immediate mortality to be almost *nil*, and his patients really to derive some benefit from the operation.

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CHAPTER XII.

MALIGNANT DISEASES OF THE STOMACH AND DUODENUM: SARCOMA.

Sarcoma of the stomach has been considered a rare disease. But Fenwick observed two examples of round cell sarcoma among "twenty-three consecutive autopsies upon persons who had died from primary neoplasms" of the stomach; and Perry and Shaw found four sarcomata among fifty museum specimens of malignant tumors of the stomach. Some of the cases recorded as such probably are not true sarcomata. Hosch has collected 102 cases of primary gastric sarcoma. He found among 13,387 autopsies, recorded in the University of Basel, that there were 168 instances of sarcoma; and that 6 of these (3.5 per cent. of the sarcomata) were primary in the stomach. According to Mikulicz and Kausch sarcoma forms from 5 to 8 per cent. of all primary tumors of the stomach. The metastatic is much less rare than the primary form.

Yates found from a study of the literature that from 28 to 45 per cent. of the reported tumors were of the round cell variety, from 32 to 36 per cent. of the spindle cell form, while lymphosarcoma constituted from 15 to 35 per cent. of cases. Mixed tumors are frequent, among those encountered being the myxomatous and the angeiomatous; fibro-sarcomata and myo-sarcomata also are not unusual. Cysts may form from hemorrhages or necrotic processes in the central parts of the tumor. Indeed it is not unfrequently impossible for even a skilled pathologist to determine whether such a tumor is a myoma, a myxoma, an angeioma, or a true sarcoma; and when the existence of a mixed form is indubitable, it may be impossible to say whether the angeioma, the myoma, etc., was the primary growth and was originally benign, or whether the tumor was malignant (sarcomatous) *ab initio*. This uncertainty was noted when describing benign tumors of the stomach, and is merely recalled here in passing, since any dis-

cussion of moot points in pathology would be out of place in a work of this kind.

Under the title of endothelioma carcinomatosum von Bergmann (cited by Borrmann) described a tumor within the layers of the great omentum so firmly attached to the stomach at its greater curvature near the pylorus, that resection of the gastric wall was required. It was a cystic tumor, and in Borrmann's opinion its point of origin was the stomach.

The sarcomatous growth usually commences in the submucous tissues, and the mucosa may remain intact for a considerable time. The tumor frequently attains a considerable size, and may project into the cavity of the stomach or may protrude beneath its serous coat, sometimes invading the gastro-hepatic or the gastro-colic omentum.

Gastric sarcoma has been found, according to Yates, at the cardiac orifice in 6 per cent. of cases, at the fundus in 58 per cent., at the pylorus in only 36 per cent. (compared to 60 per cent. of carcinomata found at the pylorus); and no more than 9 per cent. of those at the pylorus produced obstruction. About one-third of the tumors were more or less diffuse. Yates found that metastasis was noted in 70 per cent. of the round cell sarcomata and lympho-sarcomata, and in less than 50 per cent. of the spindle cell variety. The kidneys (in 28 per cent.); the liver, ovaries, pancreas, adrenals and omentum (each in 14 per cent.); and the lungs, diaphragm, pleuræ, œsophagus, intestine, and mesentery (in about 7 per cent.), are the organs most often involved (Fenwick). The skin presented metastatic nodules in about 12 per cent. of the reported cases. Hosch calls particular attention to the fact that whereas sarcomata in general (throughout the body) give metastases to the liver in 40 per cent. of cases, those which were primary in the stomach produced secondary hepatic growths in only one-tenth of the recorded cases.

Symptoms.—The symptoms due to the presence of a malignant growth, namely, anæmia, emaciation, etc., are similar to those encountered in patients with gastric carcinoma; but pyloric obstruction, which is usual in the latter disease, is seldom seen in cases of sarcoma of the stomach; and a history of long standing dyspepsia is also rare. Tests of the gastric secretion give results similar to those obtained in

carcinoma. Fenwick lays stress upon the great enlargement (non-malignant) of the spleen, in 15 per cent. of patients with sarcoma of the stomach; this enlargement, when present, is an important differential sign. Perforation is said to be more frequent (11 per cent.) than in carcinoma of the stomach. Hemorrhage is characteristic of the angeiomatous and myomatous forms. Carcinoma and sarcoma have been found associated twice in the stomach.

Diagnosis from carcinoma is rarely possible before operation, and often a distinction can be reached only by microscopical examination. The age of the patient is an unreliable guide: among 70 cases where the age was recorded, Hosch found 27 patients under 40 years of age, 26 over 50 years of age, and 17 (the greatest number in any decade) between 40 and 50 years. The very marked prostration of strength, the excessive anæmia, and the early occurrence of slight but persistent pyrexia, all speak in favour of sarcoma. When the abdomen is opened, one would be inclined to diagnosticate sarcoma from the existence of a well defined tumor, especially if of rather large size, not obstructing the pylorus, softer and more vascular than a carcinoma, situated on one of the gastric walls or at the fundus, rather than along the lesser curvature; and from the absence of perigastric adhesions.

Prognosis. Without operation the average duration of life is "fifteen to eighteen months for the round cell, and twenty-four to thirty-two months for the spindle cell forms, both distinctly longer than carcinoma." (Yates.)

Treatment.—If a satisfactory diagnosis cannot be reached within a few weeks, exploration should be urged. To the 24 operations for sarcoma of the stomach collected by Lecène and Petit, may be added 8 since reported (Yates (4 cases), McCormick and Welsh (2 cases), Halsted, Oberst). The result in two of these latter cases (reported by Yates) is not recorded. Of the 30 operations whose outcome is recorded, 17 patients recovered, and 13 died, a total mortality of 43.33 per cent.

The following table, modified from that of Lecène and Petit, shows the operations employed, the number of patients, with the results.

OPERATIONS FOR GASTRIC SARCOMA.

	Cases.	Rec.	Died.
Exploration	1	0	1
Gastro-enterostomy	6	1	5
Gastrectomy	8	5	3
Gastric resection	11	10	1
Resection of tumor and transverse colon (see page 298)	1	0	1
Drainage of subacute perforation	1	0	1
Tumor removed without opening stomach	1	1	0
False anus for chronic obstruction of colon	1	0	1
	30	17	13

Considering alone those cases where radical operation was done, we have a total of 21 operations, with 5 deaths, or a mortality rate of less than 24 per cent.

Of twelve patients who recovered from operation, referred to by Corner and Fairbank, four were reported as being alive and well after 4, 5, 12 and 24 months respectively since operation. According to Lecène and Petit, three patients were reported well over one year after the operation, and one of these three (operated on by Capello) was well more than two years after the operation.

REFERENCES.

v. Bergmann: Petersb. med. Woch., 1897, xxii, Heft. 3; cited by Borrmann: Mitth. a. d. Grenzgeb. d. Med. u. Chir., 1900, vi, 543.
Corner and Fairbank: Trans. Path. Soc. London, 1905, lvi, 32.
Fenwick: Cancer and Other Tumours of the Stomach, London, 1902, p. 274.
Halsted: Annals of Surgery, 1906, ii, 638.
Hosch: Deutsch. Zeit. f. Chir., 1907, xc, 98.
Lecène and Petit: Revue de Gyn. et de Chir. Abd., 1904, viii, 965.
McCormick and Welsh: Scottish Med. and Surg. Jour., 1906, xix, 299.
Mikulicz and Kausch: System of Practical Surgery, ed. by v. Bergmann and Bull, Phila., 1904, iv, 369.
Oberst: Beitr. z. klin. Chir., 1905, xlv, 477.
Yates: Annals of Surgery, 1906, ii, 599.

MALIGNANT DISEASES OF THE DUODENUM.

Carcinoma.—This affection is rare. Ewald found only 19 carcinomata of the duodenum among 1148 cases of intestinal carcinoma. Perry and Shaw, among 18,000 autopsies, found 4 carcinomata (0.05 per cent.) and 6 sarcomata of the duodenum. Fenwick found 18 carcinomata of the duodenum among 19,518 autopsies (0.09 per cent.). He calculated therefore that cancer occurs only once in the duodenum for over twenty times it is found in the stomach.

Duodenal carcinoma is usually described according to the relation it bears to the bile ducts, as supra-ampullary (para-pyloric), juxta-ampullary (peri-ampullary), and infra-ampullary (juxta-jejunal). Of these forms the juxta-ampullary is the most frequent. Schüller collected 41 cases of primary malignant tumor of the orifice of the common bile duct. Among 51 cases of duodenal carcinoma collected by Fenwick, 11 (21.5 per cent.) involved the first part; 29 (57 per cent.) were in the second or descending portion; and 7 (13.5 per cent.) in the third (transverse) portion. In the remaining cases (8 per cent.) the duodenum was diffusely infiltrated by the malignant growth.

Apart from the supposition that duodenal carcinoma usually developes from a preceding ulcer, little is known of the ætiology. The studies of Ménétrier on this subject were referred to at p. 271. Mayo reports having observed three cases of primary carcinoma of the duodenum, in one of which certainly, and in a second probably, the malignant growth was engrafted on a previously existing benign ulcer. In the third case the disease was too far advanced for any decision to be reached.

Most duodenal carcinomata are of the cylindrical celled variety (adeno-carcinoma). The growth, especially when adeno-carcinoma, usually constricts the intestine, and symptoms of obstruction are therefore prominent. When viewed from outside the gut, the ap-

pearance is as if a "string had been tied tightly around the bowel" (Fenwick). If above the bile papilla, the symptoms of pyloric obstruction are so closely simulated as to make a correct diagnosis extremely difficult, if not impossible. When upon, or in the immediate neighbourhood of the biliary opening, chronic jaundice is present, and differentiation from stone in the common duct, from chronic pancreatitis, etc., becomes important. Dilatation of the stomach, usually absent in affections confined to the biliary and pancreatic tracts, is an important differential sign. These matters will be more fully discussed in our second volume. Below the orifice of the common bile duct, obstruction of the duodenum is less difficult to diagnosticate: the nearly constant presence of bile in the vomitus is a most important symptom. If this were due to a gastro-biliary fistula, instead of regurgitation of bile from the duodenum, the vomitus would not be found to contain the pancreatic ferments as well as bile.

Operation must usually be palliative—gastro-jejunostomy being the procedure likely to produce most comfort. Maylard's patient lived several months after cholecystostomy. Syme resected three inches and a half of the third portion of the duodenum for an annular carcinoma, restoring the intestinal canal by end to end anastomosis of the duodenum by suture. His patient recovered and was in good health three months later. Schüller refers to ten palliative operations for carcinoma of the biliary orifice; one patient lived two years, but the majority died in a few days. In one case Czerny (cited by Schüller) did transduodenal excision of such a growth, re-implanting the common duct into another part of the duodenum; his patient died 8 days later, and autopsy showed that a radical operation was useless as there were already metastases in the liver. In one patient at the German Hospital, Dr. Deaver excised from the juxta-pyloric portion of the duodenum a small nut-sized tumor found on microscopical examination to be carcinomatous. The patient recovered, and was in good health over 1 year after the operation.

Sarcoma of the duodenum has been reported in about 21 cases (Fenwick). Obstruction is rare, the tumor being rather soft and vascular than constricting. Fatal hemorrhage has been noted (Rolleston).

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Deaver: Archives of Diagnosis, 1908, i, 244.
Fenwick: Cancer and Other Tumours of the Stomach, London, 1902, p. 284.
Maylard: Glasgow Med. Jour., 1907, lxvii, 306.
Mayo: Annals of Surgery, 1907, i, 810.
Perry and Shaw: Guy's Hospital Reports, 1893, l, 171.
Schüller: Beitr. z. klin. Chir., 1901, xxi 683.
Syme: Lancet 1904, i, 148

CHAPTER XIII.

INJURIES OF THE DIAPHRAGM, STOMACH, AND DUODENUM.

Of the various injuries to be considered in this chapter, the majority are rare occurrences in civil hospitals. The nationality of patients has also a considerable influence in determining the relative frequency with which stab-wounds and gunshot wounds are encountered, while subcutaneous ruptures are almost exclusively confined to city hospitals with large accident services. Stab-wounds are therefore more frequent in southern Europe, and among Italian laborers in this country, than in other portions of our population; while gunshot wounds are rare in northern cities, except from negro brawls, compared to their incidence in the southern states, where the experience of one surgeon may embrace a hundred or more operations for such injuries.

I. Injuries of the Diaphragm.—These are of interest to the abdominal surgeon because of the frequency of abdominal complications.

(**A**) **Stab-wounds.** These usually result from penetration of one of the lower (sixth to tenth) intercostal spaces on the patient's left. The lung is rarely injured, but the dagger, if it penetrates the diaphragm, not unfrequently punctures the stomach, the colon, or the omentum. Among 73 operations for wounds of the diaphragm, analyzed by Suter, there was injury of the abdominal contents in 24 cases, or 33.33 per cent.

The *symptoms* are chiefly those of shock and hemorrhage. The omentum frequently, and the stomach or colon occasionally, protrudes in the thoracic wound; this is of course pathognomonic of penetration of the abdominal cavity. The physical signs closely resemble those of diaphragmatic hernia (see p. 259). Operation should be undertaken before sufficient time has elapsed for evidences of peritonitis to appear.

The *prognosis* without operation is very bad. Sorrentino (1895) refers to 33 cases in which no operation was done. Of these patients, 29 died, a mortality of 87.8 per cent. Among the 29 deaths, 15 occurred soon after the injury, giving an immediate mortality without operation of 50 per cent.; the other 14 patients lived for months or years, and then died from conditions which prompt operation can prevent. The causes of death in the patients who died soon after injury were as follows:

Incarceration of abdominal organs in wound of diaphragm,	7 patients.
Extravasation of gastric contents into pleural cavity,	5 "
Hemorrhage,	1 patient.
Empyema,	2 patients.

Of those patients who survived their injuries for the time being, every one reported died later from incarceration of the diaphragmatic hernia. Although these figures are not very recent, they may be accepted as a fair indication of what the outcome of these cases must be if no operation be employed, as the non-operative treatment of such cases has changed little, if at all, since these statistics were collected.

On the other hand, the results of operation are very encouraging. Lenormant in 1903 collected 31 operations for wounds of the diaphragm, with only 8 deaths, a mortality of 25.8 per cent. Suter in 1905 analyzed 79 such operations; 70 patients recovered, a death rate of 11.4 per cent. Of the 9 fatal cases, only 2 were unaccompanied by injury of the abdominal viscera.

Treatment. It being decided that operation is indicated, it next becomes necessary to determine what the operation shall be; whether thoracotomy, laparotomy, thoraco-laparotomy, or a combined operation (an operation which opens both pleural and peritoneal cavities by means of a single incision). Suter's statistics show a very striking difference in the results which have attended these various operations. If to Suter's figures we add 14 operations (6 original, and 8 reported since the appearance of Suter's article) collected by Iselin, as well as the operation recently reported by Francis T. Stewart to the Philadelphia Academy of Surgery (January, 1908), we have the following as the latest figures:

OPERATIONS FOR STAB-WOUNDS OF THE DIAPHRAGM.

Operation.	No. of Cases.	Recovered.	Died.	Mortality Per Cent.
Thoracotomy	65	61	4	6.15
Laparotomy	19	14	5	26.31
Thoraco-laparotomy	6	4	2	33.33
"Combined operation"	4	3	1	25.00
Total	94	82	12	12.7

The much higher mortality in cases treated by laparotomy is not due, as might be supposed at first sight, to graver injuries than in the cases of patients treated by thoracotomy. Suter gives the following figures for the 24 operations in which injuries of the abdominal viscera were present:

OPERATIONS FOR STAB-WOUNDS OF THE DIAPHRAGM COMPLICATED BY INJURIES OF ABDOMINAL VISCERA.

Operation.	No. of Cases.	Recovered.	Died.	Mortality Per Cent.
Laparotomy	9	5	4	
Thoraco-laparotomy	2	1	1	50.00
"Combined operation"	1	0	1	
Thoracotomy	12	11	1	8.30

The technique of the operation is essentially the same as that for diaphragmatic hernia, which has already been described (p. 265). By laparotomy it is usually very difficult, if not impossible (1) to reduce the herniated organs, owing to the negative pressure within the thorax; (2) to repair the wound in the diaphragm; (3) to suture wounds of the cardia or the fundus of the stomach. If the herniated viscera can be reduced from within the abdomen, pneumothorax is produced by this procedure quite as surely as by the operation of thoracotomy. By the latter operation the injured viscera can be quite satisfactorily repaired, as well as the wound in the diaphragm; or if there seem good reason to believe that further abdominal injuries exist, inaccessible to treatment from above, the abdomen may be opened subsequently. Pleural infection occurred, according to Suter, in less than 10 per cent. of the whole number of operations.

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Gibbon: Annals of Surgery, 1908, i, 634.
Iselin: Deutsch. Zeit. f. Chir., 1907, lxxxviii, 150.

Lenormant: Revue de Chir., 1903, xxviii, 617.
Sorrentino: Riforma Medica, 1895, xi, Fasc. 2, pp. 75; 88.
Stewart: Annals of Surgery, 1908, i, 633.
Suter: Beitr. z. klin. Chir., 1905, xlvi, 341; xlvii, 403.

(B) **Gunshot Wounds** of the diaphragm have no interest apart from the accompanying visceral injuries. Yet Robert has reported the case of a patient who died from strangulated diaphragmatic hernia one year after a gunshot perforation of the diaphragm, from which he had recovered without operation.

REFERENCE.

Robert: Cited by Forgue and Jeanbrau, Revue de Chir., 1903, xxviii, 813.

(C) **Rupture of the Diaphragm.** *Subcutaneous* as distinguished from *percutaneous* injuries of the diaphragm are extremely rare. Iselin advises, and we believe justly, that primary laparotomy be the operation of choice in these cases, since extensive lesions of the abdominal viscera are more frequent than in the case of stab-wounds, and hemorrhage from ruptured blood-vessels may be inaccessible by the thoracic route. If it be difficult to reduce the herniated organs, the surgeon may create a pneumothorax by a small intercostal incision, whereupon reduction will be easy. After the more serious lesions have been repaired (hæmostasis, suture of gastro-intestinal perforations, etc.), and if the patient's condition permit, the surgeon may open the thorax and suture the rent in the diaphragm from above. If collapse of the patient prevent this step of the operation, the rupture should be tamponned from the abdominal wound, in the hope that protective adhesions may form. Omentum, and even liver or stomach might be sutured in place to stop the gap.

It has been possible to find references to only five operations for subcutaneous rupture of the diaphragm. Two patients recovered.

1. Guibal. Laparotomy by Villemin: herniated organs reduced; profuse hemorrhage; wound hastily tamponned. Patient died in a few minutes after return to bed. Autopsy showed rupture of spleen, liver and left kidney.
2. Walker. Laparotomy: small bowel withdrawn from rent, which it was impossible to suture. Recovered.

3. Knaggs. Laparotomy by Berry, 5 days after injury; hernia reduced; liver sutured against rent in diaphragm. Died on table.
4. Martin. Operation for incarceration 5 days after injury. Died.
5. Suter. Incision as for nephrectomy; suture of rents in diaphragm, and left nephrectomy. Recovered.

REFERENCES.

Guibal: Bull. et Mém. Soc. Anat. Paris, 1900, lxxv, 507.
Iselin: Deutsch. Zeit. f. Chir., 1907, lxxxviii, 150.
Knaggs: Lancet, 1904, ii, 359; Case 4.
Martin: Cited by Iselin, loc. supra cit.
Suter: Beitr. z. klin Chir., 1905, xlvi, 341.

(**D**) **Operative Wounds of the Diaphragm.** Iselin refers to four instances of operative wounds of the diaphragm, recorded by Humbert, Leisrink, König, and Hahn. The operations of Humbert, Leisrink and König consisted in resecting part of the diaphragm for sarcoma; that of Hahn was for enchondroma. Humbert and König's patients recovered, but those of Leisrink and Hahn died.

REFERENCE.

Iselin: Deutsch. Zeit. f. Chir., 1907, lxxxviii, 150.

II. Injuries of the Stomach.—From its anatomical relations, surrounded by liver, diaphragm, pancreas, colon, and spleen, it is very rare to encounter uncomplicated wounds of the stomach. Among 228 cases of penetrating wounds of the abdomen collected by Siegel in 1898, the various viscera were injured as follows:

Viscus Injured.	Stabwounds.	Gunshot Wounds.
Stomach	4	71
Small intestine	12	52
Liver	6	31
Colon	5	15
Spleen and kidneys	2	14
Omentum, mesentery, etc.	3	13
	32	196

Of 532 cases treated without operative intervention, 238 recovered, and 294 died, a mortality of 55.2 per cent. Of 376 cases in which operation was done, 182 recovered and 194 died, a mortality of 51.6 per cent. The difference, when the figures are thus given, between medical and surgical treatment, is not striking; but when regard is had to the time elapsing between the accident and the operation, it is quite evident that surgery offers the only reasonable hope of cure.

OPERATIONS FOR PENETRATING WOUNDS OF ABDOMEN.

Operation.	Mortality.
Within 4 hours of injury	15.2 per cent.
From 5 to 8 hours after injury	44.4 " "
From 9 to 12 hours after injury	63.6 " "
More than 12 hours after injury	70.0 " "

(**A**) **Stabwounds.** The stomach is one of the organs least often wounded in penetrating stabwounds through the abdominal wall. Among 75 instances of penetrating wounds of the stomach collected by Siegel, there were only 4 cases of stabwound. In former times bayonette wounds of the stomach were not very rare, and Tuffier calls attention to the fact that suicidal stabwounds are a cause, especially in women, who, in aiming at the supposed location of their heart (below the left breast), usually wound the fundus of the stomach.

The *diagnosis* depends more upon the symptoms than upon the position of the wound. In rare cases the stomach may be penetrated by a stabwound in the back (Benoit). As previously noted, wounds

of the stomach are not unfrequent complications of transpleural perforations of the diaphragm (p. 310). Shock, vomiting of blood, and the escape of gastric contents through the wound may render the diagnosis of perforation of the upper intestinal tract certain; but in all cases the wound should be explored before peritonitis has had time to develope, for the question as to which viscus is injured is of relatively little importance. In Lyng's case there was no doubt as to the penetration of the stomach, since the instrument (a hay-fork) which produced the wound, had pieces of meat and potato sticking to it, and the patient had just finished a meal composed largely of these articles.

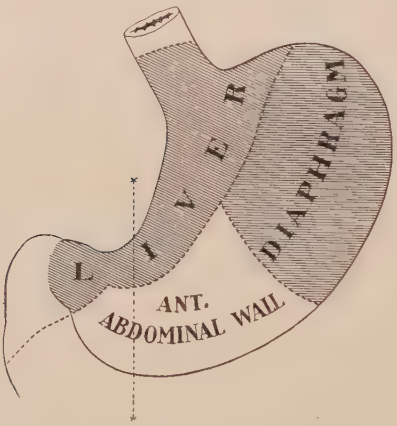

Fig. 30.—Diagram to Show Overlapping of Anterior Gastric Wall by Surrounding Structures.

Treatment. If protrusion of the omentum or other abdominal contents renders the fact of penetration of the abdomen certain, no hesitancy need be felt in freely opening the peritoneal cavity; but if the stab-wound is small and there is doubt as to whether the blade has actually entered the peritoneal cavity, cautious exploration should be undertaken. The patient being anæsthetized, and prepared as for an abdominal operation, the surgeon should dissect down layer by layer, and thus follow the track of the wound. It is sometimes impossible to follow a small stabwound directly; under these circumstances it is best to lay bare the abdominal aponeurosis (sheath of the rectus, aponeurosis of external oblique) over a wide area, and search it carefully for the stabwound. If this cannot be found, and it is known that the blade was very short (that of a pen-knife for example), and if there are no other symptoms of penetration, the skin incision may now be closed. If, however, it be ascertained that the blade has penetrated the aponeurosis, the surgeon should next lay bare the transversalis fascia and peritoneum, but should not open the latter

until he is sure it has been penetrated. It is often impossible to trace a small stabwound across fatty tissue and muscular fibres; and it is usually inadvisable to make any attempt to insert a probe in the path of the wound, as by doing so not only are false passages usually produced, but the probe itself may penetrate the abdominal cavity when the latter had not been invaded by the original instrument. But by arresting his dissection at the aponeurotic and peritoneal layers of the abdominal wall, the surgeon will be able to determine in almost all cases the existence or the absence of penetration of the abdominal cavity. We are thus insistent upon this cautious approach, and upon

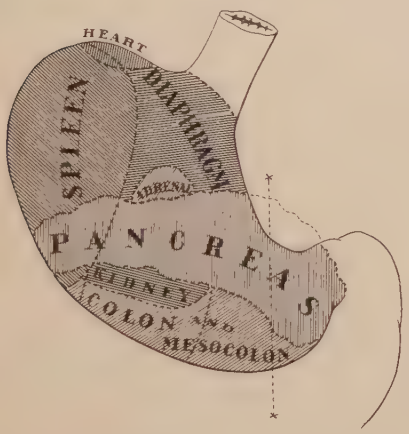

FIG. 31.—DIAGRAM TO SHOW RELATIONS OF POSTERIOR GASTRIC WALL TO SURROUNDING STRUCTURES.

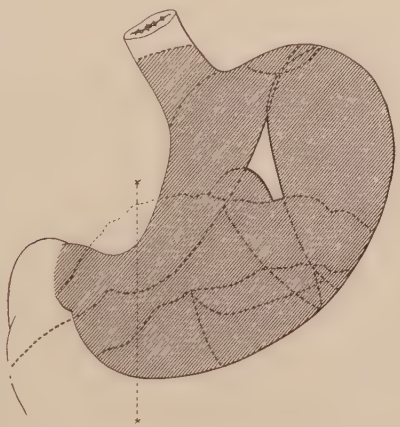

FIG. 32.—DIAGRAM MADE BY SUPERIMPOSING FIG. 31 ON FIG. 30 TO SHOW CLOSE RELATIONS OF STOMACH TO SURROUNDING STRUCTURES.

determining beforehand whether the peritoneal cavity has been penetrated by the weapon, because it often happens that on opening the abdomen widely in these cases inspection shows no evidence of intra-abdominal lesion, and very extensive search becomes necessary to exclude the possibility of visceral injury; and if none be found to exist, and it is shown that the vulnerating weapon itself had never opened the peritoneal cavity, the surgeon will have subjected his patient to a quite unnecessary and by no means trivial operation. If, however, the fact of abdominal penetration has been definitely

determined in doubtful cases by the method just described, the surgeon will be quite justified in his extensive intra-abdominal manipulations, even though no lesion be found more serious than hemorrhage from an omental vein.

Although the mortality for penetrating stabwounds of the abdomen is in general about 50 per cent., yet the earlier the operation, the greater the chance of recovery. Siegel found that for those patients operated on within the first twenty-four hours, the mortality was only 8.7 per cent., considerably less than for gunshot wounds.

Stab-wound of Right Gastro-Epiploic Artery.—Maiocchi has recently reported an operation for a large hæmatoma in the gastro-colic omentum due to a stabwound of the right gastro-epiploic artery, without other important lesion.

OPERATIONS FOR STAB-WOUNDS OF THE STOMACH.

(Exclusive of Those Through the Diaphragm.)

1. Büdinger. Laparotomy 7 days after injury. Recovery.
2. Cahen. Laparotomy and suture three hours and a half after injury. Recovery.
3. Fuchsig. Laparotomy and suture after 12 hours. Recovery.
4. Kirchner. Multiple stab-wounds of thorax and abdomen. A coil of small intestine, completely severed, protruded through thoracic wound; the stomach protruded through one of the abdominal wounds. Immediate laparotomy: resection and end-to-end anastomosis of small intestine, with Murphy button; suture of stomach and diaphragm. No irrigation. Abdomen closed without drainage. Recovery after empyema.
5. Lyng. Laparotomy and suture after 15 hours. Recovery.
6. Preindlberger. Laparotomy and suture. Recovery.
7. Rehn. Laparotomy after 9 hours. Died.
8. Siegel. Laparotomy after 3 hours. Recovery.
9. Wrigley. Laparotomy after 2 hours; suture of wounds in anterior and posterior wall. Recovery.

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Benoit: Cited by Tuffier, loc. infra cit., p. 143.
Büdinger: Arch. f. klin. Chir., 1898, lvi, Heft. I.
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Fuchsig: Wien. klin. Woch., 1904, xvii, 884.
Kirchner: Med. Fortnightly, St. Louis, 1908, xxxiii, 40.
Lyng: St. Paul Med. Jour., 1904, vi, 124.
Maiocchi: Gaz. d. Ospedali, in Revue de Chir., 1908, xxxviii, 337.
Preindlberger: Zentralbl. f. phys. Therap. u. Unfallh., 1904, i, 135.
Rehn: Cited by Siegel, loc. infra cit.
Siegel: Beitr. z. klin. Chir., 1898, xxi, 395.
Tuffier: Chir. de l'Estomac, Paris, 1907, p. 142.
Wrigley: Brit. Med. Jour., 1907, i, 1303.

(B) Gunshot Wounds of the Stomach. In only 32 out of 126 cases of gunshot injuries of the stomach, collected by Forgue and Jeanbrau, was this the only viscus wounded; in other words, in about three out of every four cases gunshot wounds of the stomach are complicated by serious injuries of neighbouring organs. The position of the stomach, moreover, is such that not only will it be liable to injury in the case of gunshot wounds of the abdomen, but also in those of the lower thorax, its greater tuberosity reaching as high as the fifth rib on the left. This is one of the reasons why gunshot wounds of the lower thorax give a higher mortality, and more urgently call for operative treatment than do those of the upper portions.

Gunshot injuries of the stomach are divided by systematic writers into (1) *Perforations*—usually double, there being one wound of entrance, and another of exit; (2) *Abrasions*, or *Excoriations*—in which the gastric wall is wounded without being perforated; and (3) *Contusions*,—which may affect either the serous or the mucous aspect of the organ.

The occurrence of only one perforation in the stomach, may be explained in various ways. Among 112 cases studied by Forgue and Jeanbrau (to whose excellent monograph, already quoted, surgeons are indebted for most of their modern statistics), in only 13 did no more than one perforation exist. The ball may never have entered the stomach at all, having merely struck it a glancing blow, sufficient to penetrate its cavity, but because of its tangential course passing on without traversing this cavity. In only 3 cases was the bullet known to have lodged in the stomach. It may make its exit by perforating the duodenum near the pylorus, or the œsophagus close to the cardia; and it is even conceivable that a second perforation (wound of exit)

may occur in the small retroperitoneal portion of the gastric wall below the cardia, and that the second perforation will thus be impossible of discovery from outside the stomach, as the serous covering of the organ will have been wounded in only one place. Cases are on record in which the bullet, entering the stomach, has been passed subsequently by the bowel, and one in which the bullet was vomited.

According to Forgue and Jeanbrau there are on record only 4 cases of the second class of gunshot wounds of the stomach; while contusions, forming the third class, are equally rare. In a patient of their own, the bullet perforated and lodged in the stomach; it produced a contusion (undiscovered at operation) of the mucous membrane of the opposite wall. Although this patient did well for three days after operation, he died eventually from profuse bleeding into the stomach from an ulcer which formed as a result of this traumatism.

A distinction is to be drawn between gunshot wounds of military, and those of civil life. The former are almost always rectilinear, owing to the high velocity of the projectile; and the bullet as a rule perforates the patient's entire body, unless arrested by bone; or at least lodges beneath the skin on the distal side of the body. Bullets from injuries of civil life, however, are more easily deflected from their course on entering the body, and rarely if ever pass completely through the trunk. The high initial velocity of the modern military bullet gives it also a well defined explosive action on a hollow viscus if filled with fluid or semi-solid matter, provided the range be less than 1800 feet (Borden); civil bullets, on the contrary, owing to their much lower velocity, scarcely ever have an explosive effect, even on a full stomach.

Symptoms. The most important symptoms are those of shock and internal hemorrhage. Hæmatemesis is frequent. Operation (in civil life) should be undertaken before evidences of peritonitis have time to develope.

Diagnosis. Though perforation of the stomach may be suspected in any patient in whom the wound of entrance lies in the area of vulnerability of the stomach (see Fig. 32), and also in certain other cases where the known course of the bullet lies in the direction of the stomach, though the wound of entrance may be at some distance

(loin, thorax, perineum, etc.); yet the only certainty consists in exploratory laparotomy.

Prognosis. Apart from the method of treatment adopted, the condition of the stomach when wounded has a most important influence on the prognosis. If the stomach be empty, and the patient remain in the recumbent position after the injury, extravasation will be very limited, and the developement of peritonitis much delayed. Forgue and Jeanbrau include in their study 45 patients treated without operation, and 82 patients treated by laparotomy. In the case of the former patients the death rate was 46 per cent.; in the latter it was 42 per cent. Taking these figures as they stand, they do not seem to encourage surgeons in urging laparotomy as a life-saving measure. But a number, in fact the majority of these operations are not of recent date, and it is but reasonable to suppose that the immediate mortality of operations for gunshot wounds of the stomach has improved along with that of all other departments of gastric surgery, since the date—five years ago—when these studies were published. Accordingly it is no surprise to find that among 25 recent operations for gunshot wounds of the stomach, collected in 1907 by Walton Martin of New York, there were only 6 deaths—a mortality of less than 25 per cent. And although it is probable that both series of statistics give too favourable a prognosis, being founded on collected cases, rather than on a consecutive number of cases treated in one hospital, or by one surgeon; yet their comparative value, showing a marked reduction in the mortality after modern operations, is not affected by this circumstance. But even with the less recent figures of Forgue and Jeanbrau, a little closer inspection will show that the difference between the results of expectant and operative treatment is quite conspicuous. If, for example, we consider apart those cases in which the stomach was the only organ injured, and those in which the gastric lesions were complicated by other serious injuries, we find that in the former class of patients (19 cases), operation was attended by a mortality of 42.10 per cent., while among the latter (63 cases) the death rate was 68.25 per cent.; if, however, no operation was employed, 46 per cent. of those patients (13 cases) with only gastric lesions died, and 93 per cent. of those (32 cases) with wounds of other

organs succumbed. As it is absolutely impossible to know before beginning the operation whether other organs besides the stomach are injured or not, it is incumbent upon the surgeon to operate on all cases, in order to decrease the mortality of the much more frequent class of injuries from nearly 100 to less than 70 per cent.—or, if we accept Martin's more recent figures, to as low as 25 per cent.

In military practice, gunshot wounds of the stomach, especially those at close range, are almost always fatal. No operation can be undertaken successfully on the field of battle; Tuffier quotes the statement made to him by a Russian surgeon who went through the entire Russo-Japanese campaign: not one patient with perforating gunshot wound of the abdomen, treated by laparotomy, recovered. By the time such patients have been transferred to the nearest hospitals, they are either already dead, or peritonitis is so far advanced as to render operation unjustifiable.

The importance of early operation in civil life may be seen from the following figures, copied from Forgue and Jeanbrau:

I. WOUNDS OF THE STOMACH ONLY.

	Cases.	Rec.	Died.	Mortality Per Cent.
Laparotomy within six hours of injury....	13	9	4	30
Laparotomy after unknown lapse of time.	6	2	4	66
	19	11	8	42

II. WOUNDS OF OTHER VISCERA AS WELL AS THE STOMACH.

	Cases.	Rec.	Died.	Mortality Per Cent.
Laparotomy during first six hours.....	29	13	16	55
Laparotomy during second six hours....	13	2	11	85
Laparotomy after lapse of twelve hours..	13	2	11	85
Laparotomy after lapse of unknown time.	8	3	5	62
	63	20	43	68

Treatment. The bullet wound should be disinfected, partial excision of its margins being employed if necessary, and any particles of clothing carried into the wound (as in President McKinley's case) should be removed. Discarding the instruments used for this purpose, the surgeon should open the abdomen by an epigastric incision, passing through the left rectus muscle *close to the median line.* Or after

opening its sheath, the rectus muscle may be displaced to the outer side, and the abdomen opened without separating the muscular fibres. It is proper to follow the track of the bullet only when there is reasonable doubt of its penetration. A very oblique impact in a patient with a very fat abdominal wall may result in the bullet making a non-penetrating wound involving only the abdominal wall, with lodgement of the bullet in the flank, the hypogastrium, or even one of the thighs. But in the vast majority of cases there will be no doubt of the bullet's penetration; and under these circumstances a median incision gives the best exposure. The "head high" (reversed Trendelenburg) posture, with a sandbag under the patient's lower dorsal spine, is a great help in exposing the field of operation. Intra-abdominal hemorrhage must first be checked; then the search for perforations is begun. The stomach is to be located immediately beneath the left lobe of the liver, and as soon as a perforation is found, it should be wiped clean, and inverted with at least two rows of Lembert sutures of fine linen thread. The first tier may be in the form of a pursestring suture. It is not advisable to search for other perforations until the first has been sutured. If a wound of exit cannot be found on the anterior wall of the stomach, the gastro-colic omentum should be divided, between clamps, and below (on the colic side of) the gastro-epiploic arteries, for a distance of *at least three inches*. A free abdominal incision and a free opening in the gastro-colic omentum will do much to hasten the subsequent steps of the operation. The existence of a perforation in the posterior wall usually will be indicated by extravasation within the lesser peritoneal cavity. Walton Martin states that among the cases he studied, the failure to suture the bullet-hole in the posterior wall of the stomach had not

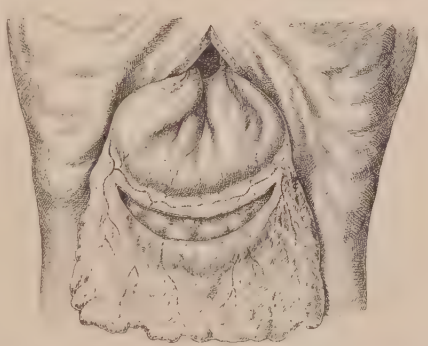

Fig. 33.—Wide Opening of the Gastro-colic Omentum to Explore Posterior Gastric Wall.

materially influenced the mortality. Should, however, a perforation be detected in a position which was inaccessible to suture, the surgeon may by gastrotomy (incising the anterior wall of the stomach) evert the posterior wall through the gastric incision, and suture the posterior perforation from its mucous surface. Sometimes the perforation in the anterior wall of the stomach is not accessible through a median wound. This is most frequently the case when the perforation is at the fundus or near the cardia. Under such circumstances it is best to adopt temporary resection of the costal margin, after the plan advocated by Auvray. In this, an incision is made from the upper angle of the median laparotomy wound, at the ensiform process, obliquely downward to the tip of the tenth left rib; this incision is carried down to the costal cartilages, and these are then divided, from their sternal attachment outward, including if necessary the cartilage of the tenth rib itself. If care be exercised to keep the line of incision in the cartilages, and not to invade the osseous structure of the ribs, the pleural cavity will not be opened. By pulling upward on the costal border thus cut loose, the tranversalis muscle and the diaphragm may be detached from the internal aspect of the ribs, and then in order to open the peritoneal cavity it only remains to divide the peritoneum and the transversalis fascia (Forgue and Jeanbrau). The little extra time occupied in making this section is fully justified by the free exposure it gives of the fundus of the stomach. Should the diaphragm have been perforated by the bullet, it would probably be better to approach this region of the stomach by the transpleural route (p. 264). Whenever the gunshot wound traverses the thorax and wounds the abdominal organs the question will arise as to the advisability of draining the pleural cavity. Walton Martin advocates drainage of the pleural cavity in the majority of such cases; and we are inclined to agree with him. A pneumothorax is unavoidably established in such cases through the diaphragmatic wound as soon as the abdomen is opened, and in most cases it probably will be wise to drain the pleural cavity from the outset by an intercostal incision.

After repairing the gastric wounds, search must be made for other perforations, in the colon, the duodenum, and neighbouring coils of small intestine. Wounds of the liver and spleen, and sometimes those

of the pancreas, owing to the free hemorrhage which usually attends them, will probably have received attention even before those of the stomach.

Usually sufficient drainage of the lesser peritoneal cavity can be obtained by a wick of gauze carried down through the gastro-colic omentum. In rare cases it is advisable to make drainage through the left loin, below, or even above, the tip of the twelfth rib. This route has been particularly studied by Mauclaire, and was successfully employed in a patient recently reported to the Philadelphia Academy of Surgery by E. B. Hodge, Jr. In very few cases will it be safe altogether to dispense with drainage of the lesser peritoneal cavity. This should never be done if there is the least suspicion of injury to the pancreas.

The clamps left on the cut margin of the gastro-colic omentum are now used as tractors, drawing the colon up against the stomach; and by their aid the incision in this structure may be repaired by sutures (which also serve for hæmostasis), except where the drain emerges. It is usually safer to leave another drain to the sutured area on the anterior gastric wall; and as many more gauze packs are to be inserted as may be necessary to localize the peritoneal infection.

If temporary resection of the costal arch have been employed, it will of course be necessary to re-attach the diaphragm to the lower surface of the cartilaginous flap, and to restore the latter to its place by the aid of deep sutures including skin and intercostal muscles.

Forgue and Jeanbrau point out that suture of perforations near one of the gastric orifices may cause stenosis. They suggest that, in desperate cases with pyloric wound, the pyloric perforation might be sutured to the abdominal wall (temporary pylorostomy). A formal pylorectomy could be done only on a patient whose general condition would warrant the additional time and shock which this operation entails. Gastrostomy would be the chief resort in cases where suture of a perforation near the cardiac orifice caused occlusion of this opening.

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(C) **Rupture of the Stomach.** This may be either the so-called "*spontaneous*" rupture, or the *traumatic* variety.

(1) Under the name **spontaneous rupture of the stomach** certain cases have been reported, some of which are more accurately described as ruptures from within (pseudo-spontaneous ruptures), since they were clearly due to the trauma inflicted by lavage. Long ago, Orth recorded a fatal gastric hemorrhage from the passage of a stomach tube; and Key Aborg and Strassmann have each observed multiple ruptures of the gastric mucosa, as the result of too forceful lavage in patients dying of opium poisoning. In another patient of Strassmann's, with gastric cancer, complete rupture of the gastric wall was produced by lavage, and at autopsy the stomach contents were found in the peritoneal cavity. In a patient of Wunscheim's a carcinoma of the œsophagus ruptured into the aorta after the passage of a sound, and at autopsy there were also found rents in the mucous coat of the stomach. Haberda has reported a fatal case of complete rupture of the stomach due to its artificial distention with air; and Ungar observed a similarly fatal case due to the distention of the stomach produced by swallowing effervescent powders.

These ruptures from over-distention are more frequent along the lesser curvature, radiating from the cardia. They have been particularly studied by Key Aborg and by Fraenckel, each of whom conducted experiments to test the elasticity of the stomach, and its most frequent site of rupture. With a view to preventing rupture, it is above all things important to perform lavage with gentleness, and at leisure; especially is this the case with patients whose stomachs are known to be seriously diseased, and in those who are unconscious, since the

sensations of the patient form a very valuable guide to the quantity of fluid which may safely be introduced into the stomach.

True spontaneous ruptures appear to have been recorded in at least nine instances. Abstracts of these cases follow, the first seven references being quoted from the well known paper on injuries of the stomach by Petry:

1. Brush. Sudden pain and collapse during effort to lift a stone; slow recovery without operation. For forty years suffered from gastric troubles. At autopsy there was found a gastro-pancreatico-duodenal fistula; the pylorus was tightly stenosed. This case appears rather apocryphal in the light of modern knowledge.
2. Newman. Insane patient; during violent vomiting after meal, developed pain, collapse, tympany, subcutaneous emphysema. Rupture of entire gastric wall found at autopsy.
3. Revilliod. Spontaneous rupture from fermentative distention. Autopsy showed no ulcer; two ruptures in serous coat.
4. Hoffman. Spontaneous rupture from fermentative distention. Death.
5. Thompson. Spontaneous rupture from unknown cause. No injury.
6. Lantschner. Stomach in umbilical hernia. After drinking immense quantity of water and tea, rupture caused by vomiting. Died.
7. Chiari. Spontaneous rupture from fermentative distention. Autopsy showed longitudinal rupture in scar of old ulcer.
8. Ipsen. Spontaneous rupture from vomiting. Death.
9. Wilke. Autopsy on patient with volvulus of stomach, showed rupture of its posterior wall causing death from peritonitis.

As pointed out by Doujon, it is quite probable that some form of gastric volvulus, self reduced before death, or undiscovered at autopsy, is the chief cause of such spontaneous ruptures in apparently healthy stomachs; and the case since reported by Wilke, and above quoted, supports this view. Strassmann suggests that these mucous lacerations may be much more frequent than is generally appreciated, and questions whether they may not form the initial stage of gastric ulcer or carcinoma. As already mentioned, other writers seem to have had the same idea. (See p. 70.)

According to Rehn, spontaneous rupture from gaseous distention is not very rare in horses, but generally is observed along the *greater* curvature.

Gastric hemorrhages, possibly due to ruptures of the mucosa, have been observed in patients who have fallen on the back, on the buttocks, and even in one injured by a "general shaking up." (Strassmann, loc. cit., S. 166.)

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(2) **Traumatic Rupture of the Stomach.** This is usually accompanied by such extensive visceral injuries as to terminate fatally before surgical treatment can be instituted. Geill in eight and a half years found 35 ruptures of the stomach at autopsy in Vienna, and Strassmann observed about the same number at autopsies in Berlin, during about fifteen years. One such case has been observed at the Episcopal Hospital, Philadelphia (1901). But as an injury which interests surgeons it must be considered rare.

The causes are blows, falls, and crushes, especially the last. Kicks by horses are also a frequent cause.

Rehn divides ruptures of the stomach into (1) those involving only the serous coat; (2) those affecting the serous and muscular coats; (3) interstitial ruptures, including submucous hæmatomata, etc.; (4) ruptures of the mucosa; (5) penetrating ruptures—those in which the entire thickness of the gastric wall is involved. From the experiments conducted by Fraenckel and others, it appears that mucous ruptures are usually produced by overdistention from within; that ruptures of the serous coat alone are frequently the result of external pressure on a distended stomach; that contusions result in interstitial ruptures; and that complete ruptures are more apt to be caused by crushing of the stomach against the spinal column.

Petry in his study of subcutaneous ruptures of the alimentary canal, found the stomach involved in 21 cases, the small bowel in 172 (of which 9 were duodenal ruptures), and the large bowel in 26 cases. Of the 21 gastric ruptures, eight he termed spontaneous, including here the case reported by Key Aborg (which we have classed as pseudo-spontaneous). These cases have already been discussed (p. 326). Of the 13 traumatic ruptures, two were submitted to operation; death quickly ensued in five of the remaining patients (11 in number), on whom no operation was done. Of the six unoperated patients, who survived, two recovered with gastro-cutaneous fistulæ, two were operated on after 4 and 2 weeks respectively, for perigastric abscesses, but eventually recovered; while in the remaining two patients, traumatic ulcers formed, which subsequently necessitated further treatment. Tawastsjerna collected in 1905, 125 cases of operation for subcutaneous rupture of the abdominal viscera, all that had been recorded since the publication of the paper by Petry, mentioned above. Of these more recent cases, 41 recovered, and 84 died, a death rate of 67.2 per cent. Meerwein in 1907 studied 93 operations for subcutaneous rupture of the abdominal viscera, recorded since 1896. He found that among 69 patients operated on within 24 hours of the injury, 38 died, a mortality of 55.1 per cent.; while of 24 patients who were not operated on until more than 24 hours had elapsed, no less than 14 died, a mortality of 66.7 per cent. Although these figures probably are relatively correct, in that they show the value of early operation as a life saving measure, there is also no doubt that,

as Meerwein points out, these results are much more favourable than are actually obtained in any consecutive series of cases. To support this assertion, Meerwein quotes the following series of operations for rupture of the abdominal viscera.

Authority.	No. of Operations.	Recovered.	Died.	Mortality Per Cent.
Neumann	21	1	20	95.2
Schmitt	7	1	6	85.7
Voswinckel	14	2	12	85.7
Hagen	17	1	16	94.1
Thommen	17	2	15	88.2
Basel clinique	18	3	15	83.3
Hildebrand	12	5	7	58.3
	106	15	91	85.8

It should be noted that the cases reported by Hildebrand have all been treated within recent years.

Only four operations for traumatic rupture of the stomach appear to have been recorded. The patient of Mikulicz had been drinking heavily, and was taken with sudden abdominal pain, followed by extreme tympany and collapse. Mikulicz first punctured the abdomen; the gas which escaped was inflammable, and smelled strongly of alcohol. By laparotomy a rupture of the lesser curvature was sutured, but the patient died three hours later. Although the stomach evidently was diseased prior to the time of rupture, it was the opinion of Mikulicz that the rupture was traumatic in origin, due either to distention from within the stomach or to unrecorded external injury. Rehn's patient fell from a second story window, but recovered after prompt suture of the rent in the stomach. Only two other operations for this condition appear to have been recorded (Thommen and Körte). Although both patients died, Thommen's lived four days, and death was found at autopsy to be due to a rupture of the duodenum undiscovered when the rupture of the stomach was sutured.

Interstitial ruptures of the stomach may cause (1) Hæmatoma; (2) Cyst; (3) Abscess. This subject has been recently the subject of an interesting monograph by Dr. Pedro Chutro, of Buenos Aires, and it is from his work that most of what follows has been abstracted. Rupture of a vessel in the submucosa is possibly the first lesion; and the hæmatoma which forms may be gradually absorbed, without

producing very acute symptoms. If of large size, however, a cyst will form, and usually this cyst becomes more or less infected from transudation through the mucous membrane which forms one of its walls. A certain amount of gastric juice may be secreted directly into the cyst, from the deep layer of the mucosa. By some such process as this there is formed an abscess, which in the patient on whom Chutro operated resembled a cold abscess in character. Zeigler operated on a patient who had received an abdominal injury some weeks previously; he found a large hæmatoma in the anterior wall of the stomach; recovery was uneventful. Similar cases, without, however, a history of injury, have been recorded by Sloane and Anderson. Sloane's patient died from typhoid fever, and the gastric condition was not suspected during life. Anderson's patient died after the hæmatoma had been drained by laparotomy. Rendu operated on a patient with an infected cyst of the gastric wall; death occurred from peritonitis. Gallois, Houlong and Leflaive recorded a case where death was due to rupture of a cyst of the posterior wall of the stomach. Chutro's own patient, a boy of 9 years, received a kick from a horse in the epigastric region; 19 days later an interstitial abscess in the posterior gastric wall was opened and drained by laparotomy; uneventful recovery ensued. Although a history of injury is certain in only the patients of Zeigler and Chutro, it seems proper to mention the others in this place, in view of what we have already learned of the character of mucous and spontaneous ruptures of the stomach.

Menne has recently made an extensive study of the **after effects of injuries of the stomach.** He collected 51 cases in which lesions of the gastric mucosa (ulcer, stenosis, etc.) followed trauma, 45 being due to direct, and 5 to indirect violence, while in one case the nature of the injury was not stated. In 24 cases the injury was produced by moving bodies impinging upon the patient's abdomen, and in 27 cases it was caused by the collision of the patient with bodies at rest. He further tabulates 8 cases of gastric hemorrhage or perforation due to more or less indirect injuries, such as muscular efforts, etc.

Rupture of Right Gastro-Epiploic Artery. An isolated case of this nature, accompanied by an insignificant tear in the margin of

the liver, due to the kick of a horse, has been recorded by Vatter. Laparotomy was done on account of symptoms of internal hemorrhage; the artery was ligated, and recovery ensued.

OPERATIONS FOR RUPTURE OF THE STOMACH.

Mikulicz. Died in 3 hours.
Rehn. Died in 4 days.
Körte. Died same night.
Thommen. Died 4 days later from peritonitis due to undiscovered rupture of descending portion of duodenum.

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(**D**) **Foreign Bodies in the Stomach.** Children, insane people, and mountebanks form the chief classes of patients to be considered here. Others by mistake occasionally swallow a tooth-plate, a piece of bone, or some similar object. Children most frequently swallow coins, buttons, pins, etc. The insane swallow almost everything; hair swallowing is done only by those with neurotic taint, frequently during convalescence from some debilitating disease, such as typhoid fever. Sword swallowers occasionally try to exhibit their art with too short a knife; it may slip from their grasp and be hurried into the stomach by involuntary efforts at swallowing. Pieces of glass, nails, and all manner of articles are sometimes swallowed by showmen.

The majority of such articles as pass through the straits of the œsophagus and reach the stomach without difficulty will also pass the pylorus, traverse the intestinal tract, and be discharged from the anus

in the course of a few days without producing any symptoms. The form, consistency, and bulk of the article swallowed, are, in the order mentioned, the characters which have most influence on the prognosis. Bodies of rounded form, such as coins, or at least those which have no prongs or sharp angles, will usually pass without trouble. Certain other articles, such as pieces of bone, may become partially digested in the stomach, and may thus, with their sharp angles rounded off, be discharged without causing injury to the gastro-intestinal tract. As far as the stomach is concerned, the size of the body swallowed is the least important factor in the prognosis, as it is almost certain that articles which can pass the cardiac orifice can also pass the pylorus. This remark, however, does not apply to long nails, slate-pencils, knives and forks, in which form is of greater importance than mere bulk.

Occasionally, as in children and in the insane, no history of swallowing a foreign body can be obtained. Apart from such a history, the symptoms of the lodgement of a foreign body in the stomach are chiefly those of pain and vomiting. The latter may be persistent, and the vomitus may be streaked with blood. In other cases, in spite of pain, no nausea is present, and appetite may even be preserved.

The *diagnosis* in acute cases is rarely difficult, because of the history. But it is frequently difficult to determine the presence of hair tumors (Œgagropile, Trichobezoar) before operation, because the patient either is not aware that she has been in the habit of swallowing her hair, or she is unwilling to acknowledge the habit. In the insane the diagnosis may be impossible without the aid of the Roentgen rays.

If the foreign body remain in the stomach, it may be quiescent for long periods; it may, on the other hand, cause ulceration, perigastritis, subacute perforation, and finally a subcutaneous abscess; in rare instances it may directly perforate the gastric wall. At least one instance (English) of perforation of the duodenum by a foreign body is on record. The patient was saved by operation. In a case recorded by Lucas, a nail which, as shown by skiagraphs, had been lodged for some weeks in the descending duodenum, was successfully removed by duodenotomy. Chaput also has removed by enterotomy a foreign body impacted in the duodenum.

The *treatment* to be adopted depends on the nature of the body swallowed. If certain to pass, the Vienna treatment, advocated long ago by Billroth, should be employed. This consists of a diet of mashed potatoes, or such similar substances as will tend to coat the foreign body and aid its passage through the intestinal tract. When once out of the stomach, it is most apt to be arrested at some point in the lower ileum. Under no circumstances should a purge be given. The violent peristalsis thus aroused is much more likely to cause perforation of the stomach or bowel, or intestinal obstruction from inflammatory œdema, than to promote the passage of the foreign body through the intestinal tract. If no symptoms are produced by the swallowed article, there need be no haste in resorting to operation, even if it is manifestly impossible for the foreign body to escape from the stomach. The Roentgen rays may be employed, and the location of the offending substance determined. As its weight may cause the stomach to descend much below its normal position, it may appear that the foreign body is in the large bowel (especially the cæcum) instead of in the stomach. The passage of a stomach tube, or the introduction of bismuth emulsion into the stomach just before a second skiagraph is made, probably will determine the question.

Gastrotomy is indicated (1) when it is clearly impossible for a quiescent foreign body to be discharged spontaneously; (2) when any symptoms arise from any variety of foreign body; (3) it is occasionally required for the removal of a foreign body impacted in the lower end of the œsophagus. The use of endogastric instruments, as employed by Chevalier of Pittsburgh, is justifiable only in the hands of a specialist. The average surgeon will consult his patient's safety much more by resorting to gastrotomy.

This operation, for this purpose, is said to have been first done by Daniel Schwabe in 1635. His patient, operated on without an anæsthetic, recovered. It was not until 1848 that the operation was repeated, by Tilanus. In 1887 Bernays collected 11 cases of gastrotomy for foreign bodies, including one of his own; he also referred to 16 other operations which consisted in extracting foreign bodies from the stomach after this viscus had become adherent to the parietal peritoneum as the result of perigastritis set up by the foreign body.

Of the 11 patients in the former series, only 2 died. The late Prof. Ashhurst refers to 50 cases of gastrotomy for the extraction of foreign bodies, 42 of which terminated in recovery. He says that "foreign bodies which have been swallowed, and having ulcerated through the walls of the stomach, had lodged in various parts of the abdominal cavity, have been successfully removed by LeDentu, Bardeleben (two cases), Nussbaum (two cases), LeFillier, and Dubois."

Among 20 recent cases of gastrotomy for foreign body, references to which are appended, there was only 1 death, a mortality of 5 per cent. Two patients (professional "sword-swallowers") whose cases are recorded by Revenstorf and Warbasse, were operated on twice, both times successfully.

The *operation* consists (1) in opening the abdomen through the left rectus muscle, or in passing to the median side of this muscle after opening its sheath; (2) in locating the stomach; (3) in drawing the stomach into the wound, and isolating it by gauze packs; (4) opening the stomach, preferably by an incision transverse to its long axis, so as not to divide the circular muscle fibres; (5) removing the foreign body by forceps or fingers; (6) suturing the gastric incision with at least two rows of Lembert sutures, or one of the Czerny and one of the Lembert type; (7) closing the abdominal wound.

The incision in the stomach should be no longer than is absolutely requisite for the extraction of the foreign body. It is well to locate the body and fix it against a convenient portion of the gastric wall before opening the stomach. Should it be impossible to remove a body impacted in the lower œsophagus, gastrostomy should be performed; this procedure was necessary in a patient under Jacobson's care in 1889; unfortunately the patient did not survive more than two days. In a similar case recorded in 1900 by Edmunds a tooth-plate was successfully removed from the lower œsophagus by gastrotomy.

RECENT CASES OF GASTROTOMY FOR FOREIGN BODY.

I. For nails, pins, spoons, keys, etc.

Benjamin: Annals of Surgery, 1907, xlv, 238. Recovered.

Chenieux: Bull. et Mém. de la Soc. de Chir. Paris, 1905, xxxi, 517. Recovered.

Godineau: Bull. et Mém. de la Soc. de Chir. Paris, 1905, xxxi, 450. Recovered.
Holding: Annals of Surgery, 1904, xl, 354. Recovered.
Lowry: Lancet, 1905, ii, 1107. Recovered.
Monnier: Bull. Méd. de Quebec, 1903–4, v, 170. Recovered.
Revenstorf and Lauenstein: Münch. med. Woch, 1906, liii, i, 1232. Recovered.
Revenstorf: Ibid. Recovered.
Warbasse: Annals of Surgery, 1904, ii, 909. Recovered.
Warbasse: Ibid. Recovered.

II. For Hair-balls.

Dandois: Bull. Acad. Roy. de Méd. de Belge, 1903, 4e. s., xvii, 1031. Recovered.
Ilderton and Thorburn: Brit. Med. Jour., 1907, i, 18. Recovered.
Juvara: Bull. Soc. méd. et nat. de Jassy, 1904, xviii, 58. Recovered.
Harvie: Jour. Amer. Med. Assoc., 1908, i, 512. Recovered.

III. For mass of wood-fibres, from chewing licorice sticks, etc.

Werder: Trans. Amer. Assoc. Obst. and Gyn., N. Y. (1903), 1904, xvi, 140. Recovered.

IV. For False teeth.

Friedrich: Deutsch. med. Woch., 1904, xxx, 526. Recovered.

V. For bodies impacted in lower Œsophagus.

Billot and Delporte: Arch. de Méd. et Pharm. Milit., 1906, xlviii, 500. Recovered.
Edmunds: Brit. Med. Jour., 1900, ii, 1438.

VI. Subcutaneous Abscess, connecting with cavity of Stomach.

Lejars: Bull. et Mém. de la Soc. de Chir. Paris, 1906, xxxii, 1122. Recovered.
McLeod: Practitioner, 1905, lxxv, 349. Died of exhaustion in 6 days.

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Ashhurst, J., Jr.: Principles and Practice of Surgery, 6th Ed., Phila., 1893, p. 426.
Bernays: Med. Brief, St. Louis, 1907, xxxv, 524.
Chaput: Bull. et Mém. Soc. Chir. Paris, 1907, xxxiii, 1217.
English: Lancet, 1905, ii, 1545.
Jacobson and Rowlands: The Operations of Surgery, Phila., 1908, ii, 460
Lucas: Report of Soc. Study Dis. Children, London (1900) 1901, i, 213.
Schwabe: Cited in Berl. klin. Woch., 1883, xx, 106.

III. Injuries of the Duodenum.—Injuries of the first portion of the intestinal tract differ from those of other portions chiefly on account of the situation of the duodenum; not only is it in close relation with other structures of the greatest importance (superior mesenteric vessels, portal vein, pancreas, etc.), but it also is quite firmly fixed on account of its retro-peritoneal position. Wounds of the duodenum, therefore, are more frequently complicated, as well as more difficult to treat, than are those of the jejunum or the ileum.

(**A**) **Stabwounds** of the duodenum, unaccompanied by more serious lesions, do not appear to have been observed. It is of course conceivable that such an isolated wound might occur, either through the loin, or from in front, grazing the liver and the colon, or even by passing through the gastro-colic omentum, and reaching the transverse duodenum.

(**B**) **Gunshot wounds** of the duodenum, unaccompanied by more serious injuries, have been observed in several instances. According to Cackovic, a gunshot wound of the duodenum was first sutured by Ramsay, in 1885. Harte reported a patient with a "grooved" wound of the first portion of the duodenum, and perinephric hemorrhage, who recovered after suture of the perforation of the duodenum by laparotomy, and arrest of the hemorrhage by packing the kidney region through the loin. Summers operated on a patient who had been shot in the right loin. A double perforation of the duodenum was found, also a perforation of the gall bladder. The latter injury, and the anterior perforation of the duodenum were repaired, by sutures, by laparotomy; and the posterior (retro-peritoneal) perforation of the duodenum, and a wound of the kidney, were tamponned through a lumbar incision. Death occurred in three days from "retro-peritoneal phlegmon," not from peritonitis.

The *treatment* of gunshot wounds of the duodenum is difficult because of their deep situation, and the frequency with which retro-peritoneal injuries are overlooked. Modern experience with mobilization of the duodenum will render access to retro-peritoneal lesions of its descending portion less difficult than heretofore. But the uncertainty which always exists as to the efficiency of closure of retro-

peritoneal portions of the intestine, makes the prognosis in such cases particularly grave. It usually will be well to drain the sutured area, particularly if it be retro-peritoneal. Drainage should always be employed, preferably through the loin, if a retro-peritoneal perforation is suspected but not definitely located; or if one is located in an inaccessible place. Resection, with end-to-end anastomosis may sometimes be required. In many instances it probably will be safer to close both ends of the duodenum, and restore the continuity of the intestinal canal by some form or forms of lateral anastomosis, as in the case of Meerwein to be quoted below.

(C) **Rupture of the Duodenum.** Because of its fixed position against the spinal column, rupture of the duodenum is by no means so unusual as might be supposed. Meerwein has recently collected 64 cases; and he refers to 18 others included in the tables previously published by Jeannel, the original references to which were not accessible to him. According to Cackovic, operation for rupture of the duodenum was first done in 1896 by Herczel. To show the relative frequency with which the duodenum is ruptured, the following figures are quoted from Gage: Duodenum, 10 cases; jejunum, 20 cases; ileum, 42 cases; colon, 6 cases. Meerwein studied the records of 28 operations for this condition: 16 patients recovered, and 12 died, a mortality of 42.85 per cent. But in 6 of the fatal cases the rupture in the duodenum was not found; so that the mortality attending the completed operations is only 27.27 per cent. Of the six fatal cases in which the rupture was found at the time of operation, three patients died at once, two died later from peritonitis, and one patient (Moynihan's) lived in excellent health for 104 days after the operation, and died then from perforation of the intestine by the Murphy button which had been employed at the operation. Sherwood has recorded a case of rupture of the duodenum, which is not included in Meerwein's statistics. This patient died seven days after suture of the rupture, from gangrene of the injured bowel.

The transverse is more often affected than the descending portion of the duodenum, and the rupture usually occurs more or less transversely to the long axis of the intestinal canal. The bowel may be

completely torn across. This is not unusual at or near the duodeno-jejunal juncture, as in Moynihan's case; the explanation probably being that the greatest strain is felt where the fixed portion ceases and the movable portion of the bowel commences. The causes are blows (especially kicks from horses), falls and crushes. Perry and Shaw refer to a case of rupture of the duodenum produced by vomiting; ruptures of the stomach existed in the same patient; none of the lesions were discovered during life.

Suture should be done where this is possible. If doubt exist as to the viability of the injured gut, excision had best be done, difficult as such an operation is. Sometimes end-to-end anastomosis is possible. In Moynihan's patient, referred to above, a boy of 6 years, a few inches of damaged gut were resected, the proximal end of the duodenum was closed, and the distal end (origin of the jejunum) was united to the stomach; as a result the whole of the bile and pancreatic juice passed into the stomach in order to reach the jejunum. As already mentioned, this patient survived in excellent health for 104 days, and died then from perforation of the bowel by the Murphy button which had been used in making the anastomosis. Meerwein found in his patient a complete transverse rupture of the duodenum where it crossed the spinal column. It was impossible to close the rupture by an end-to-end anastomosis. Accordingly the proximal end was closed by a purse-string suture; the distal end was then drawn out from beneath the root of the mesentery to the patient's left, the devitalized portion of the gut was excised, and the remaining (distal) end of the duodenum closed. A lateral anastomosis was then made between the posterior wall of the stomach and the upper jejunum (trans-mesocolic posterior gastro-jejunostomy); and finally a lateral anastomosis was made between the juxta-pyloric portion of the duodenum and the jejunum about 60 cm. (24 inches) from the origin of the latter (anterior ante-colic duodeno-jejunostomy). As a precaution gauze drains were left to all the sutured areas. The patient recovered.

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Cackovic: Arch. f. klin. Chir., 1903, lxix, 854.
Gage: Annals of Surgery, 1902, i, 331.

Harte: Annals of Surgery, 1902, i, 116.
Meerwein: Beitr. z. klin. Chir., 1907, liii, 496.
Moynihan: Brit. Med. Jour., May, 1901.
Perry and Shaw: Guy's Hospital Reports, 1893, l, 171.
Sherwood: Brooklyn Med. Jour., 1906, xx, 62.
Summers: Annals of Surgery, 1904, xxxix, 727.

CHAPTER XIV.

TECHNIQUE OF OPERATIONS.

Preparation for Operation.—Whenever practicable, it is well for the patient to pass a night or two in the hospital before the day set for operation. In cases of perforation or of hemorrhage, if the surgeon think it proper to operate for the latter as an acute condition, there is of course no time for delay. When feasible, from 24 to 48 hours should be devoted to putting the gastro-intestinal tract in as good a condition for operation as possible. For at least twenty-four hours before operation only cooked, and therefore sterile, food should be given the patient. The mouth and teeth should be thoroughly cleansed after each meal and at bed-time with an astringent and mildly antiseptic wash. Dilute alcohol, boric acid, peroxide of hydrogen, etc., are among the drugs employed in such a wash. The mouth should be kept as free as possible from any particles of food which may undergo fermentation.

A brisk purge should be administered the day before operation, preferably in the morning. Usually either Epsom salts or castor oil should be chosen, but the preference of the patient may be consulted. If given in the morning of the day before operation, the effect of the purge will wear off during the day, thus allowing the patient to have an undisturbed night preceding the operation. On the morning of the day of operation, an enema should be given to empty the lower bowel.

After the purge has acted, very little if any food should be given the patient. If any be given, it should consist entirely of such material as will be readily absorbed and will leave little if any residue in the intestinal tract.

The patient may drink freely of sterile water until within a few hours of the operation. The stomach should be empty at the time of operation, but it is only in exceptional cases that it must be emptied by means of the stomach tube. Where there is marked stasis, es-

pecially if there are putrefactive changes in the stomach, it is always advisable to empty the organ immediately before operation.

Preparation of the Abdomen.—The routine method employed at the German Hospital in preparing the field of operation is as follows: On the morning of the operation, the abdomen is thoroughly washed with green soap and water, special attention being paid to the navel. The entire abdomen is shaved and again washed with the green soap and water, gauze being used instead of a brush. It is then rinsed with sterile water, rubbed with 60 per cent. alcohol, and then with a 1–2000 solution of corrosive sublimate, and finally rinsed sparingly with Harrington's solution, the formula of which is

Hydrargyri Chloridi Corros.	3.2
Ac. Hydrochlor. Dil.	240.0
Aq. Destil.	1200.0
Alcohol (grain)	2650.0

This solution is very irritating and should be removed from the skin in about thirty seconds by rinsing the part with alcohol. A large sterile gauze dressing is then applied to the abdomen. This is removed after the patient has been placed on the operating table, after anæsthetization. The field of operation is then again thoroughly washed with green soap and water, with 60 per cent. alcohol, and with a 1–2000 bichloride solution.

General Considerations on Operative Technique.—Anæsthetic. Ether is used almost without exception. Sometimes anæsthesia is induced with nitrous oxide gas, ether being substituted as soon as consciousness is lost; but as a rule ether is employed from the beginning, the so-called "open, drop-method" invariably being used. Ethyl chloride is never used; it is seductive but dangerous. The patient is placed upon the operating table in the etherizing room, before anæsthesia is begun. We believe that this method reduces the amount of ether administered, ensures the patient lying on the table in as nearly normal an attitude as possible, and thus is advantageous in every respect. Ether is discontinued as soon as possible, and as the abdominal wound is being sutured oxygen is administered, so that consciousness begins to return as the dressing is applied. To maintain bodily warmth during the operation, the table is covered with a

hot water bed, and the patient wears a cotton jacket and has the legs and arms bandaged in the same material, or wears long stockings of canton flannel. When the patient is transferred to bed, if he is perspiring freely, it is best to change the cotton jacket for a light woolen undershirt.

Assistants. At the German Hospital, one assistant, the senior Resident Surgeon then on duty, helps the surgeon during the operation. One Sister threads needles, hands instruments, etc.; another is in charge of the gauze sponges and hands them to the surgeon as required; while a third changes the saline solutions, keeping them constantly clean and hot; and a fourth also keeps account of all pieces of gauze used, reporting from time to time to the Sister in charge of the gauze, who is responsible for the final reckoning of pieces of gauze employed during the operation. The surgeon does all the operating himself; the assistant holds retractors, and so disposes the operative field as to make operating easy.

Instruments. Very few special instruments are required. Good **retractors** are a necessity. **Rubber-covered clamps** are extremely desirable. For many years no clamps were used at the German Hospital except for gastrectomy; but even in performing gastro-enterostomy it cannot be denied that their use considerably simplifies matters, by rendering more rapid operating possible, as well as by lessening the chances of infection. Mechanical aids for gastro-intestinal anastomosis, such as the **Murphy button,** are never used except in emergencies, where it is desirable to terminate the operation rapidly, or in positions where the application of sutures is particularly difficult. Thus in doing anterior gastro-jejunostomy, which is reserved for patients with gastric cancer so far advanced as to make even a posterior palliative operation impossible, the Murphy button sometimes is used, so as to keep the abdomen open the very shortest possible time. Sometimes also, after extensive gastrectomies, where the cardiac stump is very small, it is better to use a Murphy button than to attempt formally to suture structures which are nearly inaccessible. **Gauze packs** are absolutely requisite to protect the general peritoneal cavity, to keep other abdominal viscera from prolapsing into the wound, and to maintain the vital heat of those struc-

tures which are exposed. These packs are about ten inches square, and are made by basting together six to eight layers of gauze. They are wrung out of hot saline solution as required, and are handed to the surgeon hot.

Fig. 34.

Sutures.—Two main types of sutures are used—the Czerny (through-and-through) and the Lembert (sero-serous), as shown diagrammatically in Fig. 34. The combined Czerny-Lembert suture is sometimes spoken of as Wölfler's suture. **The Czerny suture** is invariably of absorbable material; at the German Hospital iodized catgut is employed. Many surgeons still prefer chromicized catgut. This suture is designed to be hæmostatic, and should stay in the tissues long enough not only to make the anastomosis secure against secondary hemorrhage, but to procure firm union between the margins of the stomach or intestine involved. It should not, however, be of non-

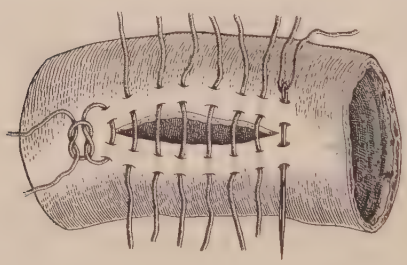

Fig. 35.

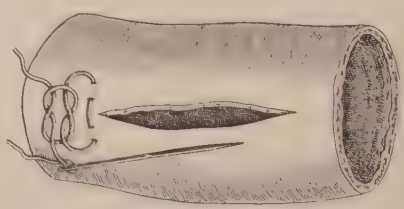

Fig. 36.

absorbable material, since then it may ulcerate out at one place, and by hanging as a loop in the lumen of the newly formed channel (Fig. 18) possibly be the cause of obstruction. Or the portions of the suture still embedded in the tissues may be torn out by the drag

of the loop which has ulcerated out, and secondary hemorrhage may be started. These through-and-through sutures are always used as a continuous suture; if there should be danger of the suture puckering the anastomosis, this may easily be prevented by arresting the suture by a knot at three or four points as it passes around the

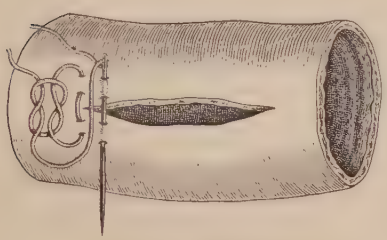

Fig. 37.

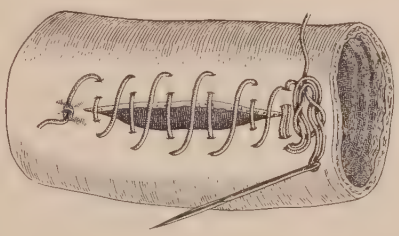

Fig. 38.

circumference of the anastomosis. Special stress is laid on this matter by Hartmann.

Sero-Serous Sutures. Various forms of this general type are shown in the accompanying illustrations. Linen thread is used in all cases, and the needle picks up all the coats but the mucous. 1. Interrupted Lembert Suture (Fig. 35) is especially applicable for reinforcing a continuous Lembert suture at any point where it appears

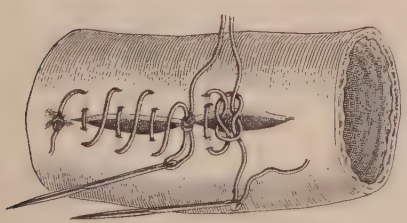

Fig. 39.

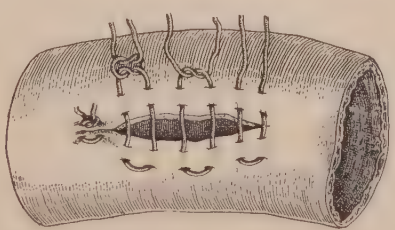

Fig. 40.

likely to leak. 2. Continuous Lembert Suture (Fig. 38) is that which is most often used in all forms of intestinal surgery. The suture is commenced by catching up on the needle a bite of the serous, muscular, and submucous coat on each side of and a little beyond the end of the intestinal wound, the needle being held at right angles to the wound.

The suture is fixed at its starting point by tying a surgeon's knot (Fig. 36). The needle then again picks up all the coats but the

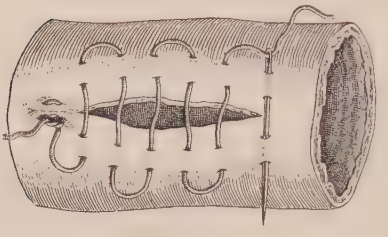

Fig. 41.

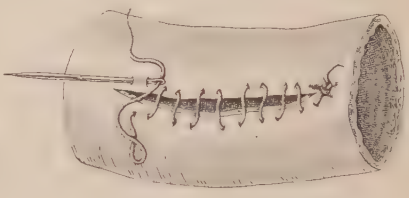

Fig. 42.

mucous on each side of the wound, crossing back to the original side of the wound before commencing each new stitch (Fig. 37), and thus continues until the other end of the wound is reached, where the thread is knotted as shown in Fig. 38. Should the suture be too short to reach the entire length of the wound, or should it unfortunately break, it may be knotted at any point, and a new suture started (Fig. 39). 3. Interrupted Mattress Suture (Fig. 40): this is particularly adapted for places where the intestine is friable, or where there is much tension on the sutures. 4. Continuous Mattress Suture is shown in Fig. 41. 5. Right Angled Suture (Fig. 42), in which the needle is inserted parallel to the edges of the intestinal wound, secures excellent approximation, and is often preferable to the continuous mattress suture, because it can be applied so much more quickly.

Fig. 43.

Closure of the Abdominal Wound.—The peritoneum is su-

tured by a continuous catgut suture, in such a way that the serous surfaces are everted into the wound, thus bringing serosa against serosa, ensuring rapid union, and leaving no projections within the abdomen to favour adhesions between the scar and omentum or other abdominal viscera (Fig. 43). This suture should begin and end beyond the extremities of the peritoneal wound, since this is apt to split further unless thus reinforced. The end of the peritoneal suture, still

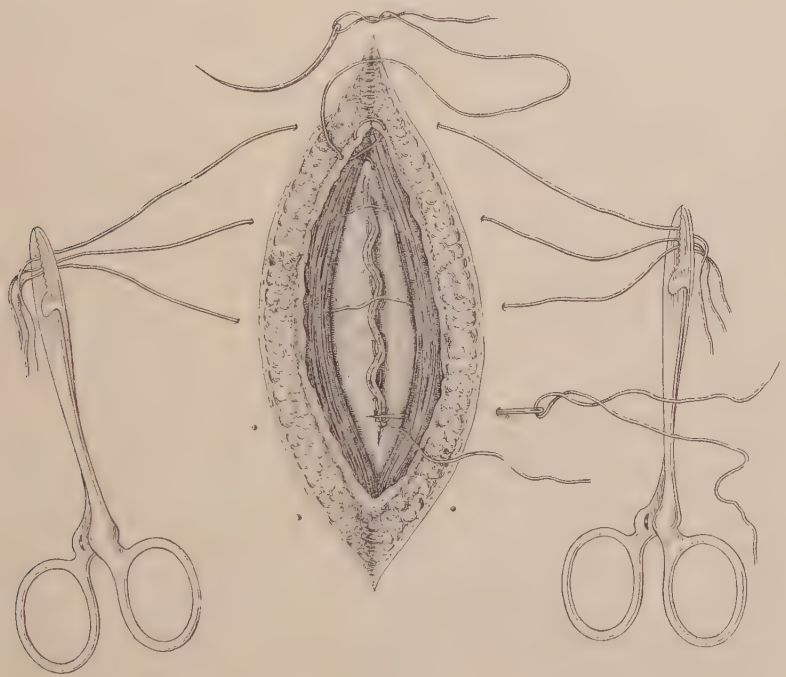

Fig. 44.

threaded, is left long; while two or three "splint sutures" of silkworm gut are introduced from the skin surface of one side through all structures but the peritoneum, and out again through the other side of the wound (Fig. 44). If the abdominal incision is very short, it is not necessary to use these splint sutures; but in any wound of more than three inches it is safer to employ them. They act not only as tension sutures, relieving the strain on the buried (absorbable) sutures, but

they also obliterate all dead spaces between the different layers of the abdominal wall, thus preventing the formation of hæmatomata and subsequent infection. When these splint sutures have all been placed, but before they are tied, the peritoneal suture first employed is continued downward, as shown in Fig. 45, uniting the anterior sheath of the rectus, and is finally tied to its own initial extremity (A to B). Finally the splint sutures are tied. (Fig. 46.) In suturing an in-

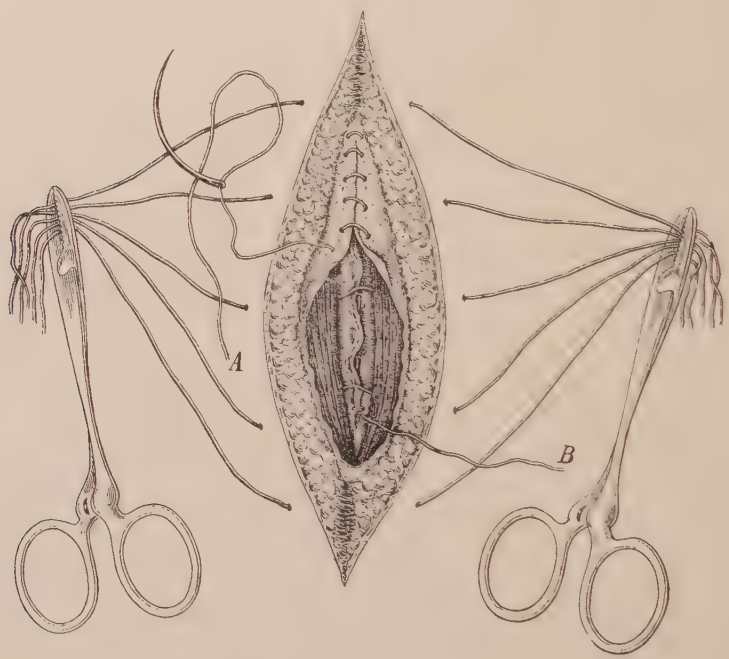

Fig. 45.

cision in a very obese patient, it is not desirable to close the skin surface too tightly. It is safer to leave space between the sutures for drainage of the products of fat necrosis. In most patients, however, accurate apposition of the skin surfaces of the wound is obtained by a running suture, and the splint sutures are tied over a roll of gauze.

After-Treatment.—The motto for Residents at the German

Hospital is "Let the patient get well." Very little after-treatment except careful nursing is required. The patients are raised up in bed as soon as the effects of the ether pass away. The head of the bed is also raised about 15 degrees from the horizontal. They are kept in a sitting posture by a pillow under their buttocks, and this pillow is kept in place by a sheet which is slung under it and fastened to the head of the bed. Vomiting is unusual; it is treated by total abstinence from mouth feeding; by sitting the patient up in bed;

Fig. 46.

by the administration of a glass of hot water; and finally by lavage. The patients do not have much pain. If they do suffer from pain, the Resident, after consultation with the surgeon, is authorized to administer a hypodermatic injection of one twelfth of a grain of morphine. But a minimum quantity of ether, speedy and orderly operating, and the routine administration of oxygen, render the subsequent use of morphine exceptional; it is given in this way in perhaps five per cent. of abdominal operations. Under no circumstances at the

German Hospital is the Resident permitted to give a dose of morphine without consulting the surgeon. Feeding—liquid diet—is not begun for from 48 to 72 hours after operation; at first small pieces of ice are allowed; then buttermilk, broths, etc.; and unless nausea prevents, soft diet is allowed in three or four days. At the end of ten days or two weeks the patients are encouraged to get up; but they should not be hurried out of the hospital before their wounds are entirely healed, nor until they are able to take care of themselves.

GASTROTOMY.

Indications. 1. For the removal of foreign bodies from the stomach, or from the lower end of the œsophagus.

2. As a preliminary to the dilatation of stricture of the pylorus, the cardia or the œsophagus.

3. For the control of hemorrhage within the stomach.

4. For the removal of polypi or other pedunculated tumors from the interior of the stomach.

5. As an incident in certain operations on the posterior wall of the stomach.

Incision. This is to be made through the left rectus muscle close to the median line, from the tip of the ensiform process downward for about three inches (7.5 cm.).

Exploration. Locate the left lobe of the liver; immediately beneath this is the stomach. While the assistant raises the margins of the abdominal incision with retractors, inspect the anterior gastric wall. If the colon bulges into the wound, pack in large gauze pads until it stays out of the operative field. If the operation is for the removal of a foreign body, palpate the stomach gently, and try to locate the body to be extracted. When the foreign body has been fixed with the fingers in contact with the anterior gastric wall, other gauze pads should be introduced so as to isolate completely the portion of the stomach wall to be opened. The stomach may be grasped with rat-tooth or Allis forceps, to facilitate this part of the operation.

Opening the Stomach. When the stomach has been isolated thus a small incision may be made in its anterior wall with a scalpel. If the object is to remove a foreign body, no longer an incision should be made than is absolutely necessary to extract the foreign body; and under these circumstances the incision is best made transverse to the long axis of the stomach, parallel with the gastric blood vessels. If, however, the stomach must be more widely opened, as for ex-

ploration of the œsophagus or the removal of an endogastric polyp, the incision in its wall is best made longitudinally, and any bleeding points should be caught in hæmostatic forceps, which will then serve the useful purpose of retractors. For exploring the œsophagus the incision should be made beneath the cardiac orifice, while if the pylorus is to be dilated, or a pyloric polyp removed, the surgeon will naturally place his incision nearer to it. In exploring the œsophagus it is well to bear in mind that the lower end of the œsophagus turns toward the patient's left, and that the cardiac orifice is frequently more or less obscured by a fold of mucous membrane. Nine times out of ten the inexperienced operator will vainly endeavour to poke a hole through the fundus of the stomach, pointing his finger to the patient's head, instead of obliquely to his right.

Closing the Stomach. When the endogastric manipulations have been concluded, the stomach wall is to be sutured with at least two layers of sutures (Czerny-Lembert). The stomach is then allowed to fall back into the abdomen; the gauze packs are removed; and the abdominal wound closed in the usual way without drainage.

GASTROSTOMY.

Indications. 1. Impermeable stricture of the œsophagus, or malignant obstruction of the cardiac orifice of the stomach.

2. It has been urged by certain European surgeons as a method of treatment of diffuse peritonitis.

3. A modified form of gastrostomy may be necessary in cases of phlegmonous gastritis.

The operation of gastrostomy, according to Sencert, was first suggested as a remedy for stricture of the œsophagus by Engelbert, a Norwegian, in 1837. It was first performed in 1849, by Sédillot, of Strasbourg. In most cases in which it is adopted it is desirable to establish a more or less permanent opening for the purpose of introducing food into the stomach. But in addition to the permanency of the fistula, it is extremely desirable to have a continent opening, one which will not leak; for leakage will not only deprive the patient of the benefit of the food which has been introduced, but will keep his clothing constantly wet between feedings, by allowing the escape of the gastric juice. A third desideratum, much less important, however, than those just mentioned, is that the fistula shall close spontaneously when it is no longer needed.

Among the many methods which have been devised for the performance of gastrostomy, it is our intention to describe only the following: 1. The methods of Witzel, of Senn, and of Kader, all of which are based on the principle of inverting the gastric wall so as to form a funnel-like channel from the cavity of the stomach to the wall of the abdomen. 2. The Ssbanajew-Frank method, in which a cone of the anterior gastric wall is brought out and laterally displaced beneath a bridge of skin before being opened. 3. The method of Tavel, of Roux, and of Herzen, in which a segment of the jejunum is used as the fistulous tract between the stomach and the skin.

1. Methods of Witzel, Senn, and Kader.—Incision. The incision is made in the left rectus muscle near its outer margin, from a little below the costal margin downward for about three inches (7.5 cm.). If the interior of the stomach is to be explored, as in cases of stricture of the œsophagus, or for other reason, the operation of gastrotomy, as described on page 351, will first be performed; and then the incision in the anterior gastric wall should be closed except at one end, where an opening should be left just large enough to admit a large rubber catheter (Nos. 26 to 28 French) or drainage tube. The gastrostomy opening should be made about midway between the greater and lesser curvatures, and in the cardiac portion of the stomach, not within the pyloric antrum. If made in the antrum, the active peristaltic contractions may not only interfere with adhesions of the stomach to the anterior abdominal wall, but there also will be greater tendency toward leakage of the gastric contents than is the case when the opening is made in the region of the fundus.

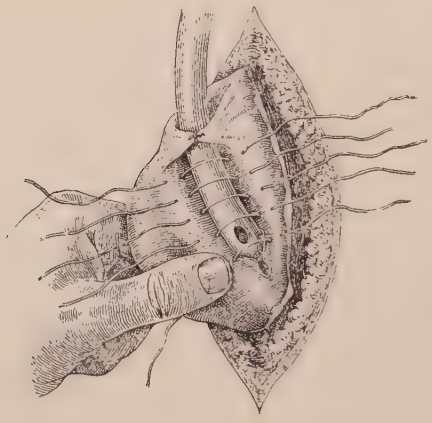

Fig. 47.—Witzel's Gastrostomy. Suturing the Catheter in Place.

(*a*) **Witzel's Method.** The catheter is laid on the anterior wall of the stomach with its gastric end toward the pyloric end of the stomach;* and the stomach wall is then sutured over it by a row of sero-serous sutures (interrupted). When the catheter is thus fixed in a serous channel, a small opening is made in the gastric wall at the pyloric extremity of the infolded area, the gastric end of the catheter is passed through this into the stomach for about an inch or an inch and a half, and is anchored in place by a single catgut suture passing through the catheter and through the entire thickness of the gastric

* Gould advises that the catheter be placed parallel with the lesser curvature, its eye pointing *upward*.

wall. The opening in the stomach wall is then buried by a few additional sutures. All these sutures should be of linen, except that used to fix the catheter in the gastric opening; by using plain catgut for this, the suture will be absorbed in four or five days, when the catheter may be removed, washed, and replaced; since by this time the adhesions of the stomach to the anterior abdominal wall will make the temporary removal of the catheter quite safe. The catheter should be clamped at its outer end to prevent leakage of gastric contents through it during the remaining steps of the operation. The stomach should now be sutured to the margin of the abdominal incision by three or four interrupted sutures which pass through all the structures of the abdominal wall except the skin and the superficial fascia. These sutures should be of linen. One should be inserted on each side of the point where the catheter emerges from the stomach, another being placed above or below, or in both situations, as may seem requisite. The abdominal wound is to be closed in the usual way without drainage, except for such drainage as takes place along the tract of the catheter.

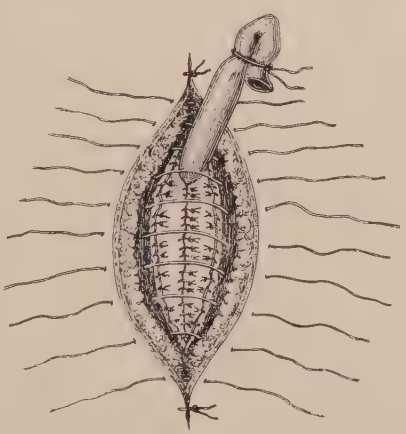

Fig. 48.—Witzel's Gastrostomy. Closure of the Abdominal Wound.

(*b*) **E. J. Senn's Method.*** A small incision, just large enough to admit the catheter, is made in the anterior gastric wall; the catheter (its outer end clamped) is inserted for about an inch inside the cavity of the stomach, and is fixed in the gastric wall by a single suture of catgut. Then a purse-string suture of linen is taken in the stomach wall, circularly around the catheter, and about three-fourths of an inch (2 cm.) distant from it; as this suture is tightened the catheter is

* Practically the same operation had been described two years previously by Stamm (1894).

pushed toward the cavity of the stomach, carrying with it the incision in the stomach wall, and thus inverting the gastric wall so that the catheter lies in a serous channel. Two other purse-string sutures are similarly passed, and as each is tightened the inverted cone of gastric wall is lengthened, so that finally the catheter lies in a channel of over two inches in length. The stomach is then sutured to the abdominal wall, as in Witzel's operation, and the operation concluded in the same way.

(*c*) **Kader's Method.** The catheter is fixed in the gastric wall as in the previous operation, and the wall of the stomach is then inverted by a series of Lembert sutures of linen passed on opposite sides of the catheter; two sutures are passed above the catheter, each picking up the sero-muscular coats of the stomach in two places, so as to form two ridges with a groove between them; two other sutures are similarly placed below the tube; then, as this first series (consisting of four sutures) is tightened, the catheter is pushed inward, and, carrying the gastric wall with it, comes to lie in a serous channel as in the operations previously described. Two or three layers of these sutures are necessary to invert enough of the gastric wall, each newly applied series burying the preceding sutures. The stomach is then fixed to the abdominal wall in the usual way, and the abdominal wound closed.

Remarks. Of these three operations, Senn's method is the simplest, and requires less of the gastric wall for its successful performance than either of the others. This is an important point when the stomach is contracted from long disuse owing to œsophageal or cardiac obstruction. We prefer it to all other methods, in ordinary cases. The channel formed from the cavity of the stomach to the skin in all these operations is usually absolutely continent so long as the catheter is in place; and unless the catheter remains in the fistula for some months after the operation the channel is prone to become entirely obliterated from adhesion of its serous surfaces. Continence during the absence of the catheter from the fistula usually improves some months after the operation, and as the serous lining will be pretty well obliterated by this time, no fear of spontaneous closure need be entertained if the catheter is left out of the fistula between meal times.

2. The Ssbanajew-Frank Method.—The first operation by Ssbanajew was done in May, 1890, and was reported in Wratsch for that year; Frank independently devised the same procedure, and employed it Nov. 23, 1892, publishing his case the following year. Both operations are really a modification of Hahn's operation of gastrostomy, while Ulmann's method of torsion of a cone of the gastric wall depends upon the same principle.

An **incision** about 7 or 8 cm. (3 inches) long through the abdominal wall is made parallel to the left costal border, centered at the end of the ninth rib. A cone of stomach wall is drawn out of this incision, and at the point on the thoracic wall reached by the apex of the gastric cone (usually over the sixth rib, 1 or 2 cm. (one-half to three-fourths of an inch) to the left of the left mammillary line) a second incision is made, parallel to the first, but only 3 or 4 cm. (one and one-half inches) in length. This incision involves only the skin and fascia. By blunt dissection a subcutaneous channel is established between the two incisions. The parietal peritoneum bordering the first incision is then sutured to the base of the gastric cone. The apex of the cone is then drawn through the subcutaneous channel to the upper incision, where it is sutured to the skin. The abdominal incision is now completely closed. The apex of the gastric cone may now be incised, and a drainage tube passed into the stomach, or its opening may be postponed for a couple of days to permit firm adhesions to form.

Remarks. This operation requires a capacious stomach for its successful performance, and the obliquity of the fistula is not maintained very long, the upper skin opening having a tendency to descend below the costal margin from the constant pull of the stomach upon it. Where incontinence does not exist, the reason is more likely to be partial sphincter-like action of the abdominal muscles, than the obliquity of the gastric fistula.

3. The Methods of Tavel, of Roux, and of Herzen.—(*a*) **Tavel's Operation** has for its object the formation of a continent gastric fistula, lined by mucous membrane. An **incision** is made through the left rectus muscle, about four inches (10 cm.) in length, and a well-nourished loop of the upper jejunum is selected, provided

with a long mesentery. The jejunum is then divided in two places, about five inches (12.5 cm.) apart, both sides of each section being guarded by rubber-covered clamps. The intervening portion of intestine is then excluded by doing an end-to-end anastomosis of the upper and lower segments. Either sutures or the Murphy button may be used for this purpose. The excluded segment is then transplanted through the transverse mesocolon into the lesser peritoneal cavity, and through the gastro-colic omentum out again into the upper portion of the general peritoneal cavity. The anal end of the excluded segment (which must be carefully distinguished from the upper or duodenal end) is then sutured into the anterior gastric wall (end to side implantation), and the duodenal end of the gut is sutured into the abdominal wound. The remaining portion of the abdominal incision is then closed in the usual manner. The peristaltic action of the bowel thus tends toward the stomach, and a continent fistula is established, lined with mucous membrane, and therefore having no tendency to contract.

Remarks. Although we have had no personal experience with this operation, having no reason to be dissatisfied with the results obtained by Senn's and by Witzel's methods, the few reported cases in which Tavel's method has been adopted have done well, and the fistula has entirely fulfilled the expectations of its inventor. It should, however, be remarked, that the operation is in itself a more serious undertaking than those already discussed, and that the time consumed, apart from the shock of an intestinal resection, will be a decided contra-indication in the case of many patients in whom some form of gastrostomy must be done. Lambotte is said to have employed Tavel's operation successfully in two patients.

(*b*) **Roux's Operation.** The purpose of this operation is to create a new œsophagus by transplanting a segment of the jejunum into the subcutaneous tissue over the sternum, and finally joining its upper end to the œsophagus above the stricture, and its lower end to the stomach. It is interesting to trace the developement of an operation seemingly so complicated. In 1894 Bircher attempted in two patients to create a channel, lined by skin, over the sternum, by means of a plastic operation on the skin, with the idea that this channel should

serve as an artificial œsophagus, by being joined above to the gullet, and below to the stomach. In 1904 Wullstein proposed an operation described as "ante-thoracic œsophago-jejunostomy." He worked out the operation on the cadaver thus: he divided the jejunum, did an anastomosis in Y, drew the distal loop of intestine through the transverse mesocolon and the gastro-colic omentum, and sutured it to the skin of the epigastrium. The cervical œsophagus was to be connected with this jejunal fistula by a rubber tube. Six months later Gluck operated upon a patient, joining an œsophageal cervical fistula to a gastric fistula. Baudouin, ignorant of others' work, proposed a similar operation in 1907.

Roux (1907) operated in the following manner (see Deaver and Ashhurst: Medical Annual, Bristol and London, 1908, p. 540):

Selecting a portion of jejunum provided with a long mesentery, he divided the bowel in two places far enough apart to allow of the intervening portion reaching from the stomach to the patient's neck. He then re-established the intestinal canal by means of a Murphy button, and withdrew the excluded loop from the abdomen after detaching only the upper two-thirds or so of its mesentery. Owing to the anatomical distribution of the blood vessels in the upper jejunum this is quite easily accomplished. After implanting the distal end of the excluded jejunal loop into the anterior wall of the stomach, the patient was fed through the transplanted jejunum, before the subsequent steps of the operation were undertaken. A subcutaneous channel was next made from the upper angle of the abdominal wound at the ensiform process to the upper sternal region, and the loop of jejunum was carefully drawn up through this channel, and its upper end sutured to the skin. The arterioles in the gut thus transplanted continued to beat normally. A stomach tube was passed down through the bowel from the neck into the stomach, and allowed to remain in place several days, to facilitate feeding while the bowel acquired firm attachments in its new situation. The progress of the case was uneventful. The child was ready to be up when the case was reported. Only a little mucus was exuded from the fistula in the neck, and no gastric regurgitation was ever observed. The operation as planned was to be concluded at a second sitting, in which the œsophagus above the stricture was to be united to the jejuno-gastric fistula.

(*c*) **Herzen,** of Moskow, has modified this operation of Roux by transplanting the excluded jejunal loop through the transverse mesocolon and the gastro-colic omentum, as in Wullstein's operation; and by dividing the operation into three stages. The first step is to do "Jejunostomia retro-colica ante-thoracica cervicalis ypsiliformis," much as in Wullstein's operation. The second stage consists in dividing the transplanted segment of jejunum above the Y-anastomosis, closing the distal end, resecting any redundant portion of the proximal loop, and implanting the anal end of the proximal loop into the stomach. At the third operation, the cervical œsophagus is united to the duodenal end of the jejunal loop, which was sutured to the skin of the cervical region at the first operation.

According to Herzen, the operation as devised by Roux has been carried out by Kocher, by Lambotte, and by Gramse, as well as by Herzen himself. All these patients had carcinomatous obstruction of the cardia or the œsophagus, and all succumbed, Herzen's patient living until the fourth day. Herzen did the first stage of his modification of Roux's operation (retro-colic ante-thoracic cervical jejunostomy in Y) on a very weak patient with cancer, who felt so much better after being fed through the jejunal fistula that he refused further treatment. The entire operation, in three stages, was done on another patient, on Sept. 10, Oct. 4, and Nov. 17, 1907 (the cervical œsophagus and the transplanted jejunum being joined by end-to-end anastomosis), with entire success, a small œsophageal fistula closing in three weeks, and the patient being in good health four weeks later, when he was shown to the Congress, and easily swallowed bread, meat-hash, eggs, etc. Intestinal peristalsis was visible under the skin of the thorax.

Remarks. That the method adopted by Herzen is an improvement over that of Roux is probably true; but the same objection lies against both that we raised against Tavel's method, namely, that in most patients such a severe operation will kill. If the operation is to be undertaken for the relief of carcinomatous stenoses this fact may not be thought to be an objection; but the surgeon is not an executioner. It does seem, however, that such an operation as this may well be of use in cases of impermeable benign stricture of the œsoph-

agus, which have hitherto baffled surgeons completely. Internal œsophagotomy and retrograde dilatation in some patients will continue to fail in the future as they have in the past to relieve the deplorable condition of those who must feed themselves through a gastric fistula; and in such patients, whose general health is good, but in whom no other means of cure is available, the operations of Roux and Herzen may be perfectly justifiable.

PYLOROPLASTY.

Inasmuch as the insufficiency of the old-fashioned **pyloroplasty** has been abundantly demonstrated, it is our intention to describe only Finney's modification. Although Finney still prefers to use the sutures as shown in the accompanying figures, most surgeons today employ rubber covered clamps, as in other operations upon the stomach and intestines. The main points, however, on which

Fig. 49.

stress is laid by Finney, are first the very thorough separation of the peri-pyloric adhesions, and second the large size of the gastro-duodenal incision, which should be not less than 12 cm. (over four inches and a half).

The operation is described by Finney as follows (Trans. Amer. Surg. Assoc., 1902, xx, 165): "Divide the adhesions binding the

pylorus to the neighboring structures, also free as thoroughly as possible the pyloric end of the stomach and first portion of the duodenum. Upon the thoroughness with which the pylorus, lower end of the stomach and upper end of the duodenum are freed, depends in large measure the success of the operation and the ease and rapidity of its performance. I wish to emphasize this as one of the most important points in the operation. Frequently at first sight the pylorus may seem hopelessly bound down, when, after a little patient toil and the judicious use of the scalpel and blunt dissector, it is found that it

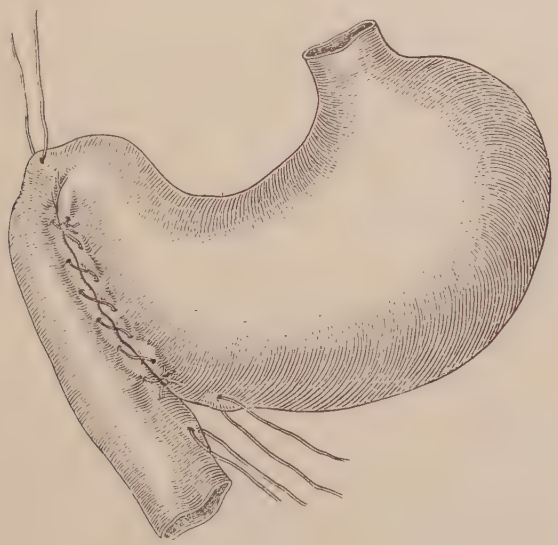

Fig. 50.

can be freed with comparative ease. A suture, to be used as a retractor, is taken in the upper wall of the pylorus, which is then retracted upward. A second suture is then inserted into the anterior wall of the stomach, and a third into the anterior wall of the duodenum at equidistant points, say about 12 cm. from the suture just described in the pylorus. These second sutures mark the lower end of the gastric and duodenal incisions, respectively. They should be placed as low as possible in order that the new pylorus may be amply large. Traction is then made upward on the pyloric suture, and downward

in the same plane, on the gastric and duodenal sutures. This keeps the stomach and the duodenal wall taut, and allows the placing of the sutures with greater facility than if the walls remained lax (Fig. 49) The peritoneal surfaces of the duodenum and stomach along its greater curvature are then sutured together as far posteriorly as possible (Fig. 50). For this row I would recommend the use of the continuous suture, as it is more easily and quickly applied, and it can be reinforced after the stomach and duodenum have been incised. After the posterior line of sutures has been placed, an anterior row of

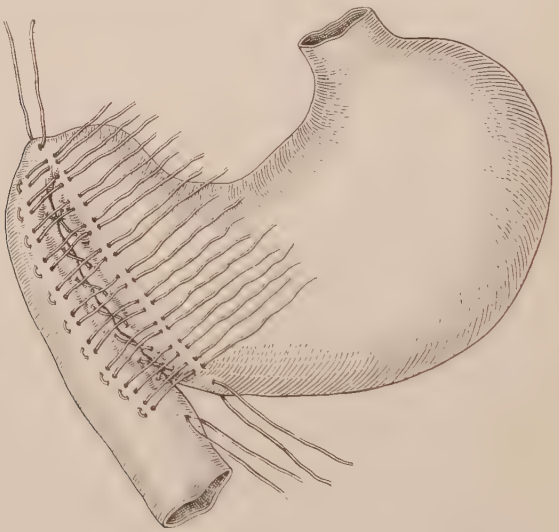

Fig. 51.

mattress sutures is taken, which are not tied, but left long, in the manner indicated in Fig. 51. These sutures, after they have been placed, are retracted vertically in either direction from the middle of the portion included in the row of sutures (Fig. 52). Then, after all the stitches have been placed and retracted, the incision is made in the shape of a horseshoe. The sutures should be placed far enough apart to give ample room for the incision. The gastric arm of the incision is made through the stomach wall just inside the lowest point of the line of sutures, and is carried up to and through the pylorus and

around into the duodenum, down to the corresponding point on the duodenal side. Hemorrhage is then stopped. It is well to excise as much as possible of the scar tissue upon either side of the incision in order to limit as far as possible the subsequent contraction of the cicatrix. It is well, too, to trim off with scissors redundant edges of mucous membrane at the new pylorus. A continuous catgut suture is now taken through and through all the coats of the intestine on the posterior side of the incision (Fig. 53). This reinforces the posterior

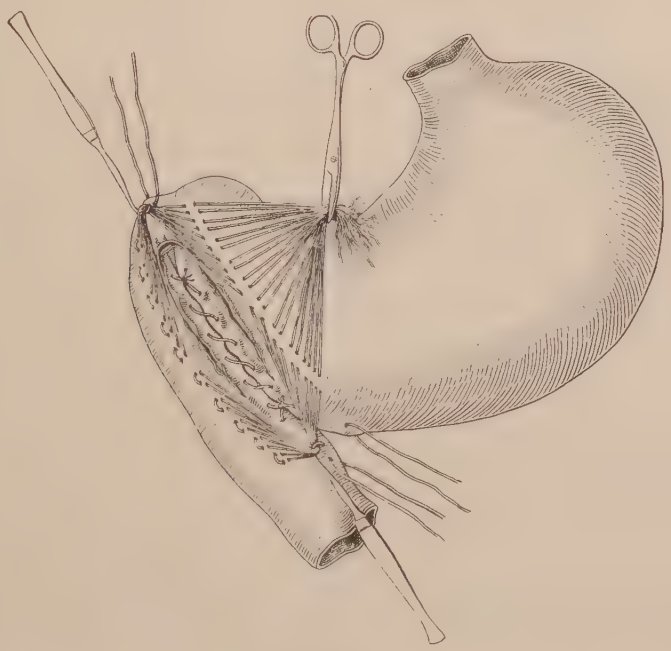

Fig. 52.

line of sutures, secures better approximation of the cut edges of the mucous membrane, and prevents the reunion of the divided intestinal walls. The anterior sutures are then straightened and tied, and the operation is complete, unless one wishes to reinforce the mattress sutures with a few Lembert stitches" (Fig. 54).

The only modifications which we have adopted in the limited number of cases in which this operation has been done, consist in

(1) the use of clamps; (2) continuing the through-and-through catgut sutures all around the gastro-intestinal anastomosis, as in other forms of lateral anastomosis, instead of only on the posterior surfaces of the incision, as recommended by Finney; and (3) in omitting the anterior row of mattress sutures, their place being taken by a continuation of the posterior row of Lembert sutures first applied. In other words, we do the ordinary operation of lateral anastomosis, as in gastro-enterostomy or entero-enterostomy.

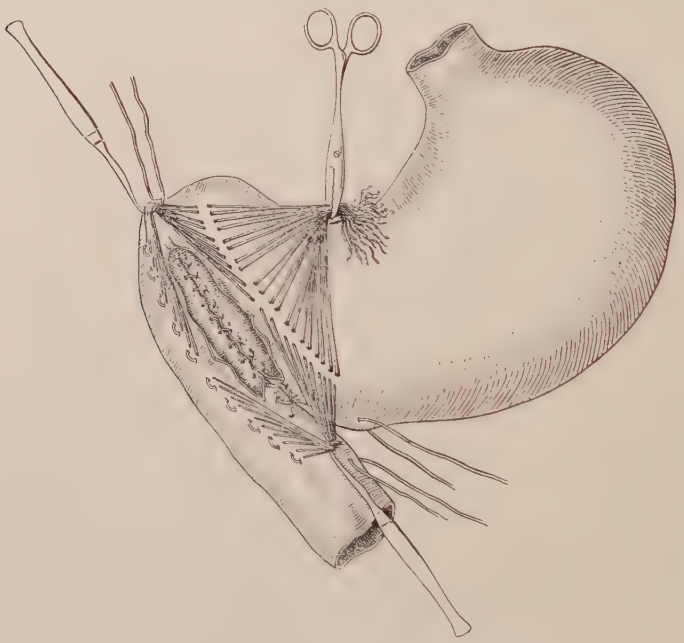

Fig. 53.

Durante's Pyloroplasty. According to Ricard and Chevrier Prof. Durante has adopted a form of pyloroplasty in which a Y shaped incision is made through the pyloric valve and the pyloric portion of the stomach. The stem of the Y divides the pylorus, and into the incision thus made, the triangular flap included between the branches of the Y is drawn and sutured, thus increasing the diameter of the pylorus at the expense of the anterior gastric wall. The principle

is the same as in Nicoll's operation for infantile stenosis of the pylorus.

Kocher's Method of Lateral Gastro-Duodenostomy is rendered possible by mobilization of the duodenum, adopted years ago

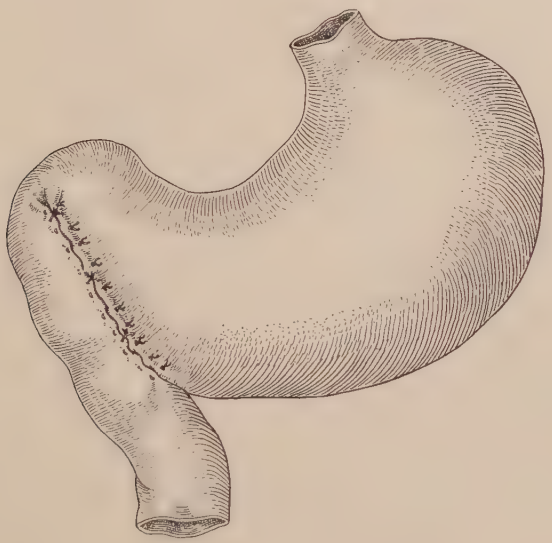

Fig. 54.

by Finney, and recently popularized by Kocher. Leriche gives the history of this preliminary step, the idea of mobilizing the duodenum apparently having originated with Terrier. The operation resembles that of Finney, except that the pylorus itself is not divided. We have employed this operation in a few cases, with satisfactory results.

GASTRO-JEJUNOSTOMY.

Historical. The operation was first performed in 1881 (at the suggestion of his assistant Nicoladoni), by Wölfler. The case was one of pyloric carcinoma, and when this was found to be inoperable, Wölfler was about to close the abdomen, when Nicoladoni suggested that by anastomosing the small bowel with the anterior wall of the stomach a new exit for the food would be provided. Although in this original operation the jejunum was attached to the stomach in an anti-peristaltic direction (that is, with its anal end toward the cardiac end of the stomach), yet it is customary to speak in general of all anterior gastro-jejunostomies as done by Wölfler's method. In 1887 Rockwitz introduced an operation in which, by attaching the jejunum to the stomach in the other direction, "iso-peristaltic" action was obtained. In 1885 v. Hacker published a method of gastro-jejunostomy by which the anastomosis was made in the posterior wall of the stomach, through an opening in the transverse mesocolon. Since that time all posterior trans-mesocolic gastro-jejunostomies by lateral anastomosis have been described in general as by v. Hacker's method.

The idea of a gastro-jejunostomy in-Y is attributed by Roux to Socin; but the latter credits its origin to Wölfler, who in his "second" method adopted this technique in connection with anterior gastro-jejunostomy. Roux calls his own method "posterior retro-colic gastro-enterostomy in-Y."

The idea of doing an entero-anastomosis between the afferent and efferent loops of the jejunum, supposed to prevent the discharge of the duodenal secretions into the stomach, is due to Lauenstein, who suggested in 1891 the anastomosis of the afferent loop with a neighbouring coil of intestine. Braun in 1892 adopted as his method an anastomosis between the afferent and efferent loops; while Jaboulay, in the same year, anastomosed the jejunum below the gastro-jejunal anastomosis with the third portion of the duodenum. To make

certain that the contents of the afferent loop would pass directly into the efferent, through the entero-anastomosis, and not continue past it into the stomach, the afferent loop (between the stomach and the entero-anastomosis) was divided and both ends closed by Doyen in 1898; while Fowler, in 1902, was content to ligate the afferent loop with silver wire. Lucke in 1899 advocated as an improvement on Doyen's method an operation (Lucke's second method) which combined the merits of the Y-operation with the advantages of the enteroanastomosis introduced by Braun. To accomplish this, Lucke divided the jejunum completely 25 to 40 cm. (10 to 15 inches) from its origin, closed both ends, and then made two lateral anastomoses—one between the posterior gastric wall and the distal segment of jejunum, and the other between the two segments of the jejunum, a convenient distance below the stomach. By this means he avoided the end to side implantations of Roux's method, which he regarded as dangerous, while at the same time he retained the advantage of the principle of the Y-anastomosis, which rendered a simultaneous entero-anastomosis unneccessary.

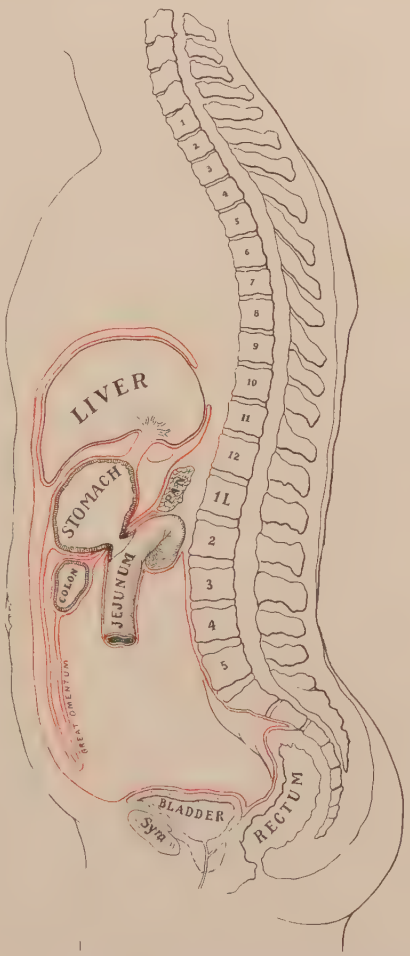

FIG. 55.—DIAGRAM TO SHOW PETERSEN'S METHOD OF GASTRO-JEJUNOSTOMY.

The most valuable modification of all was that introduced in 1901

by Petersen, of Czerny's clinique; in this operation, a posterior trans-mesocolic gastro-jejunostomy, the afferent loop was abolished, the anastomosis in the jejunum being made as close as possible to the duodeno-jejunal juncture. This remains the standard operation, and has superseded the popular short loop method formerly taught by Robson, Moynihan, Scudder, and Mayo.

It is our purpose to describe only the following methods of performing gastro-jejunostomy: 1. Anterior ante-colic gastro-jejunostomy (*a*) with clamps or the Murphy button; (*b*) with the McGraw elastic ligature. 2. Posterior trans-mesocolic gastro-jejunostomy (*a*) with long loop and entero-anastomosis; (*b*) without a loop. 3. Roux's gastro-jejunostomy in-Y.

The indications for the employment of gastro-jejunostomy have been discussed in connection with the various affections for which it may be adopted.

General Considerations. The same *incision* will suffice no matter what method be adopted. That most frequently employed is a longitudinal incision through the right rectus muscle, close to the median line. It should be about four inches (10 cm.) in length, extending from below the ensiform process nearly to the umbilicus. A very careful examination should be made of the whole operative field before commencing the gastro-intestinal anastomosis, since it occasionally happens that some other method than that originally designed will be required to meet the condition found. Especially important is it to determine the extent of the whole stomach, for, as Moynihan has pointed out, neglect of this precaution may result in the surgeon overlooking the existence of an hour-glass stomach with small cardiac pouch. We think the preference of the operator should always be for a posterior gastro-jejunostomy; hence his next step should be to determine whether the posterior wall of the stomach is accessible through the transverse mesocolon. Before proceeding with this search, the entire skin surface surrounding the abdominal incision should be covered with hot moist gauze pads, in order to protect any viscera which may have to be drawn out of the abdomen. By now drawing the great omentum with its attached transverse colon into the wound, and turning them upward on to the hot gauze pads already placed over the epigastrium and

lower thorax, the transverse mesocolon is readily brought to view. If the stomach is densely adherent to the mesocolon and the pancreas it will be impossible to withdraw the transverse colon in this way; but even after this manœuvre has been easily accomplished, it may be found that there is not a sufficient area of healthy gastric wall to permit of an anastomosis being made in its posterior surface. Under these circumstances the upper coil of jejunum should be identified before replacing the transverse colon; neglect of this precaution may result in the surgeon subsequently selecting the wrong coil of small intestine for his anastomosis. We know of several instances in which accomplished operators have by mistake anastomosed the lower ileum to the stomach. Pulling the transverse colon and the attached great omentum, as already described, out of the abdominal wound, readily brings into view the primary coil of the jejunum.

It is important to make the anastomosis in the pyloric portion of the stomach, so that the new opening shall resemble the pylorus as nearly as possible in its physiological action.

Before the gastro-intestinal anastomosis is commenced, the surgeon should isolate by the use of gauze packs the immediate structures involved, and all viscera outside of the abdomen must be carefully covered with hot moist gauze. One piece of gauze should always be passed just beneath the site of the proposed anastomosis, to be withdrawn on its completion. Usually, after the posterior wall of the stomach has been exposed through the transverse mesocolon, it will be found possible to replace within the abdomen both the transverse colon and the stomach itself, before proceeding with the operation.

Before beginning any operation in which it is proposed to use the Murphy button, its mechanism should be scrupulously and repeatedly tested by the *surgeon himself*. The lumen of each half of the button should be filled with cacao butter; this prevents escape of visceral contents, but will be melted by the heat of the body a few moments after the anastomosis has been completed (Hartmann).

Anterior Gastro-jejunostomy. The primary loop of the jejunum is identified by withdrawing the transverse colon from the wound, and seeking the duodeno-jejunal juncture in the transverse mesocolon just to the left of the spinal column. The transverse colon is then

replaced in the abdomen, and a point on the jejunum is selected which will reach the anterior wall of the stomach without constricting the transverse colon. This is usually 40 to 60 cm. (16 to 24 inches) below the origin of the jejunum. It is not necessary, nor is it desirable, to

Fig. 56.—Anterior Gastro-jejunostomy with the Murphy Button.

split the great omentum up to the transverse colon so as to render the use of a shorter loop possible. We prefer to make the anastomosis with the "Roosevelt" clamp, the technique employed being the same as that described under the heading of posterior gastro-jejunostomy (p. 377). If the **Murphy button** is to be used, a purse-string suture

of linen is inserted in a healthy portion of the anterior gastric wall, near the greater curvature, and if possible in the pyloric portion of the stomach. A similar purse-string suture is also applied to the jejunum, at the point selected, opposite the mesenteric attachment. Each of these sutures should encircle a space just large enough to permit of the introduction of a Murphy button; the sutures should not be tied, and the ends should be left long, to permit of pulling the suture tight after each half of the button has been introduced.

After these sutures have both been placed, an incision should be made in the gastric wall within the circle formed by the purse-string suture, and the male half of the button, held in the bite of a hæmostat, should be quickly passed into the incision. The gastric suture is then drawn tight, tied, and cut close. The jejunum is opened in a similar manner, the female half of the button is passed into the incision, is fixed by tying the pursestring suture; and then the two halves are approximated and pushed home. A few interrupted Lembert sutures, or a continuous suture, may then be introduced around the margins of the button. The gauze packs are then withdrawn, the viscera suitably replaced in the abdomen, and the abdominal wound closed.

It is proper to note in this place that the Murphy button is no longer approved by its inventor for use in anterior gastro-jejunostomy. While it is true that the operation may be done equally well by the use of clamps and suture, without a button, yet when it is desired to complete the operation rapidly, we believe no method is so satisfactory as the use of the Murphy button. And although we employ the clamps whenever possible, we have elected to describe the use of the Murphy button in connection with anterior gastro-jejunostomy, because that is about the only form of gastro-intestinal anastomosis in which the surgeon cannot invariably dispense with such an aid. Murphy has modified the button so that an oval instead of a circular opening may be made; but we have had no personal experience with this newer form.

Some surgeons prefer to use the **elastic ligature** introduced in 1884 by J. McFadden Gaston, who used it in experiments on dogs, and which has been proved to be practicable, and has been popularized by McGraw. By its use the actual time consumed in completing the

operation has been very much reduced. McGraw reported that it took him only three minutes to accomplish the gastro-intestinal anastomosis by the use of his rubber ligature. The Mayos, Murphy, and Ochsner, have also spoken favourably of this method. The two chief objections to it, as stated by Alfred H. Gould are (1) that the elastic ligature does not free itself by pressure necrosis until after the lapse of from three to five days, during which time no benefit can be obtained from the gastro-intestinal anastomosis; and (2) that through certain errors in technique the anastomosis may be irregular in outline, or the ligature may not cut entirely through.

The rubber ligature, according to Gould, may be obtained in three sizes: large, 5 mm. in diameter; medium, 4 mm.; small, 3 mm. (one-fifth to one-eighth of an inch). Gould states that the medium is the preferable size, because, although it does not cut through as quickly as the larger size, it is more elastic. Ochsner uses the small size.

The McLean needle is to be preferred for introducing the rubber ligature. This needle is provided with a large eye in its blunt end, the eye being open on one side, like that of the Reverdin needle when its slide is withdrawn. Into this open eye the ligature is passed, being stretched until it is small enough to enter easily. A ferrule is then slid down over the end of the ligature.

The technique of the application of the rubber ligature is as follows:

No clamps are necessary, as the viscera to be anastomosed are not opened during the operation. Placing the coil of jejunum selected against the stomach, a posterior layer of Lembert sutures is introduced, as in ordinary methods of lateral anastomosis. McGraw prefers an interrupted suture. At least three inches (7.5 cm.) of stomach and intestine should be united in this manner. By now pinching the stomach up into a fold transverse to its long axis, the needle may be made to penetrate the base of this fold (about 1 cm. from the line of sutures), and, while the rubber ligature is stretched until its diameter becomes less than that of the needle, the latter is withdrawn on the far side of the fold of gastric wall. As this fold flattens out, it will be seen that the two punctures have been made at points two or three inches apart, and that as a consequence the rubber ligature passes for that distance

within the cavity of the stomach. The jejunum is then pinched up into a fold of similar size, the base of the fold is transfixed by the needle (but in the reverse direction), and when the elastic ligature emerges again opposite its starting point, it is there knotted.

It is very important to make sure that the needle has really entered the lumen of the stomach and bowel, since in some reported cases the needle merely dissected the mucosa free from the muscular wall without entering the cavity of the intestine or the stomach except for a very short distance.

To prevent the knot in the rubber ligature from slipping it is important to fix each half of the knot by tying around it a strand of silk or linen. Great care must be taken not to let the line of the primary sero-serous sutures slip into the grasp of the rubber ligature as it is drawn taut.

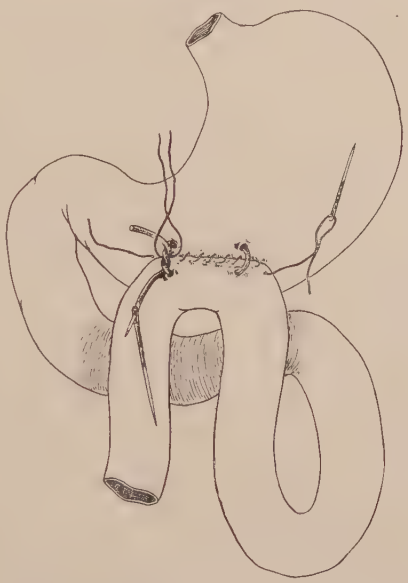

Fig. 57.—Diagram to show Use of the Elastic Ligature of McGraw.

Finally the posterior row of sero-serous sutures is continued around the site of the anastomosis, which is considerably puckered up by tying the elastic ligature. This completes the operation; and the newly formed channel will be opened in a few days by the sloughing produced by the constriction of the elastic ligature. Murphy found that this sloughing occurred fastest at the point constricted by the knot of the rubber ligature, and hence advises making another half knot at the other end of the proposed anastomosis; of course, as this knot cannot be pulled through the lumen of the intestine, it is necessary, in using this technique, to have the ligature threaded at both ends.

Posterior Gastro-jejunostomy. (A). *Long Loop.*—The trans-

verse colon and the attached omentum are drawn out of the wound, and by pulling these structures upward and to the patient's right the transverse mesocolon is put upon the stretch and the origin of the jejunum brought into sight. Selecting now a bloodless area to the left of the main trunk of the middle colic artery, the transverse meso-

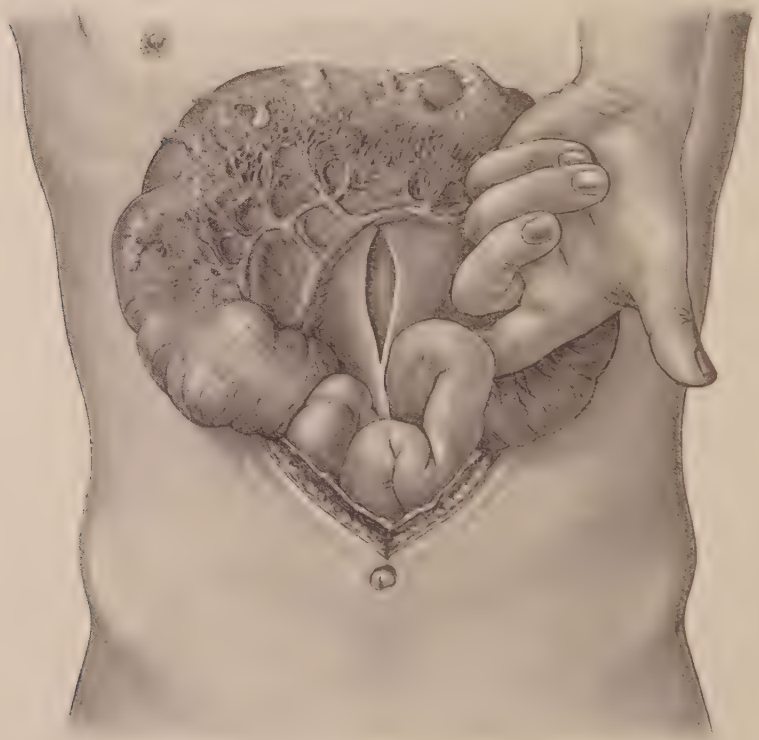

Fig. 58.—Picking up the Primary Loop of the Jejunum. The Transverse Mesocolon has been Incised to the Left of the Middle Colic Artery.

colon is here torn through with dissecting forceps, and the opening enlarged in the sagittal plane, by the fingers or by a few snips with scissors, until it is about three or four inches (7.5 to 10 cm.) in length. The left hand of the operator, which holds the transverse colon between finger and thumb, the fingers being on the upper sur-

face, can now make the posterior gastric wall protrude into this opening in the transverse mesocolon. It will usually be found that the portion of the gastric wall thus brought to view is that immediately beneath the cardiac orifice, and that it is quite close to the greater curvature of the stomach. One pair of gastro-enterostomy clamps, its blades sheathed in rubber tubing, is then applied to the posterior gastric wall, holding in its grasp a generous fold of the stomach, so as to allow plenty of room for the application of the sutures. The base of the fold of gastric wall thus grasped should be at least three inches (7.5 cm.) in length and the portion grasped should be in the pyloric antrum, not in the body or fundus of the stomach. The direction in which the forceps are placed is immaterial; as a rule they should be placed more or less parallel to the greater curvature of the stomach. The primary loop of the jejunum is now brought forward, and a point about ten inches (25 cm.) from its origin is selected for the anastomosis. The bowel is grasped in the other pair of rubber covered forceps for an equal distance, about three inches (7.5 cm.). A small piece of gauze is then laid beneath the parts to be approximated, and the clamps are placed side by side in front of this gauze, with the coil of the jejunum in an iso-peristaltic direction. (Dr. Deaver usually employs a three-bladed clamp, known as the "Roosevelt.") The transverse colon and all the viscera not immediately concerned in the anastomosis are then replaced inside the abdomen, and the entire operative field is isolated by sterile gauze. The stomach and the jejunum, which are maintained in apposition by an assistant who holds the two pairs of clamps, are now to be united by a posterior sero-serous continuous suture of linen thread. This suture should be applied as close as possible to the blades of the clamps, so as to leave plenty of room for the through-and-through sutures. The posterior row of sutures should commence a little beyond one extremity of the proposed anastomosis, and is to be continued a little past the other end, where it may be knotted to prevent puckering of the anastomosis (as advised by Hartmann). The ends of this suture should be left long, and, with the needle still threaded, it should be laid aside and covered with sterile gauze until again needed.

An incision about two and a half inches (6 cm.) long is now made

with a scalpel through the serous and muscular coats of the stomach, about one centimetre (approximately one-third of an inch) distant from the continuous suture just inserted. When the mucous layer of the gastric wall is thus exposed, it will pout a little into the incision; it is then to be picked up with forceps and cut off with scissors, flush with the margins of the incision. The gastric secretions should be wiped away, and when the incision in the stomach is dry, the jejunum should be opened in a similar manner, and for an equal distance; less of the mucosa of the jejunum than of the stomach will prolapse, and it is not always necessary to excise it. All the instruments which have come into contact with the gastric or intestinal contents should now be discarded.

The surgeon now has the cavity of the stomach and that of the jejunum opened, and a posterior sero-serous suture applied. He should next unite the adjacent free edges of these viscera by a through-and-through continuous suture of chromicised (or iodized) catgut. Beginning at one extremity of the incisions into stomach and jejunum, the needle is passed from the mucous surface of the jejunum through its wall to its serous surface, and from the serous surface of the stomach into the cavity of the latter. The suture is then fixed by knotting it; and by continuing to suture in a precisely similar manner the posterior margins of the incisions are united from one extremity to the other. The suture may be knotted from time to time if desired, to prevent puckering, as taught by Hartmann; usually this is unnecessary. When the surgeon reaches the end of the posterior margins of the gastric and jejunal incisions, he should continue his suture carefully around the end, and begin the approximation of their anterior margins. As these are not held in close apposition by the clamps, as were the posterior margins, it is a little difficult at first to understand how to continue the suture so as to secure the approximation of serosa to serosa. If the surgeon, however, pursues precisely the same method already adopted, he will have no trouble with this part of the operation; he should pass his needle from the mucous surface of the jejunum to its serous surface, then from the serous surface of the stomach to its mucous surface, draw the stitch tight, and repeat the process. To put it briefly, the needle is passed *out*, *in*, and *over*; *out*, *in*, and *over*; etc.

—that is to say, *out* of one organ, *into* the other, and *over* the line of sutures, to again pass *out* of the jejunum, *into* the stomach, and across the suture line back to the starting point. By drawing each stitch fairly tight, it is easy to determine the point where the needle should next be inserted. About four or five stitches should be made to every inch. When the entire circumference of the anastomosis has been united by this through-and-through suture, the catgut thread is tied to its own original end, at the starting point, and cut short. The sero-serous suture, previously laid aside, is now to be resumed, reinforcing the anastomosis on its anterior aspect, and completing the circumference of the wound to its starting point, where it is to be tied to its own initial extremity and cut short.

It is usually advisable, so soon as the through-and-through sutures have been completed, and all danger of contamination from gastric or intestinal contents has been thus eliminated, to release the rubber covered clamps; for it is not desirable to keep them in place too long, as there is always a possibility of long continued pressure injuring the gastric or intestinal walls. It is convenient, however, to keep one blade beneath the anastomosis, as a sort of bridge to hold the viscera in place, until the anterior sero-serous sutures have been completed (Munro). Any bleeding points observed when the clamps are removed, should be caught up in special sutures.

When the gastro-intestinal anastomosis has been finished in this manner, the surgeon should thoroughly rinse his gloved hands in corrosive sublimate and then in sterile water. It is often better to put on another pair of sterile gloves.

The edges of the opening in the mesocolon are next to be sutured to the gastric wall a short distance away from the anastomosis. This is a very important step in the operation, and should never be forgotten. It prevents prolapse of coils of small bowel into the lesser peritoneal cavity, and also keeps the mesocolon from constricting the anastomosis itself or from slipping down over the afferent and efferent loops of jejunum and thus causing obstruction. It is well to place a stitch at each extremity of the opening in the mesocolon to keep the incision from tearing larger. It is also the custom of the senior author to insert an "anchor suture" to hold the jejunal loop in contact with the

gastric wall at the jejunal end of the anastomosis so as to prevent kinking of the jejunal loop by sagging.

The gauze surrounding the field of operation is now to be removed; as that piece of gauze immediately underlying the anastomosis is drawn out it will rotate the anastomosed structures far enough to enable

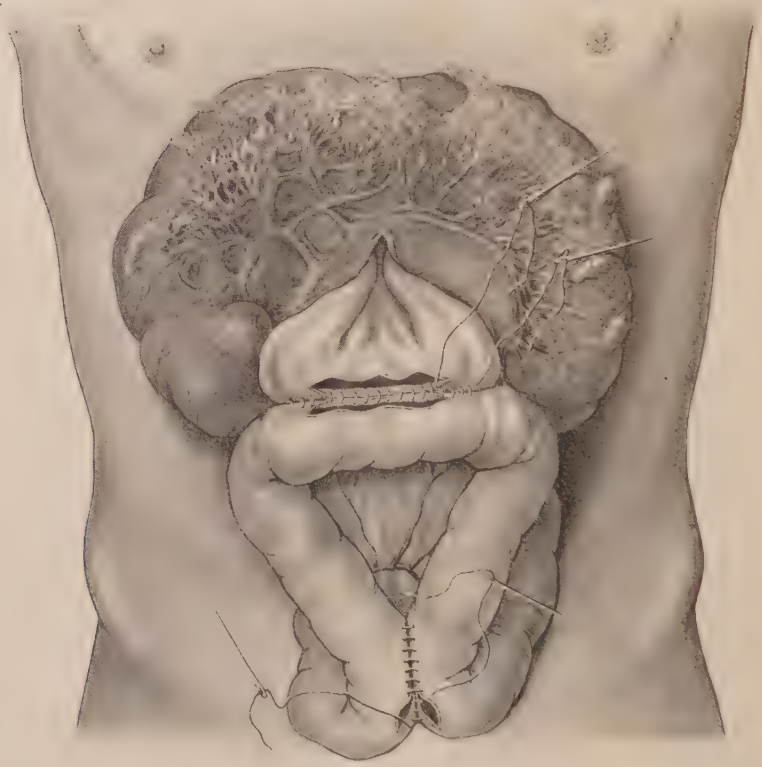

FIG. 59.—POSTERIOR GASTRO-JEJUNOSTOMY WITH ENTERO-ANASTOMOSIS. FOR SIMPLICITY THE RUBBER-COVERED CLAMPS ARE NOT SHOWN.

the surgeon to inspect the posterior line of sutures, and thus to assure himself that all is in good condition on that surface of the anastomosis.

If no entero-anastomosis is to be done, the viscera are carefully replaced in the abdomen, the great omentum is drawn down over the small intestines, and the abdominal wound is closed.

Entero-anastomosis may be accomplished by the use of clamps by precisely the same technique of lateral anastomosis as that just described for gastro-jejunostomy; or a Murphy button or the McGraw elastic ligature may be used, if it should seem desirable to hasten the operation. The anastomosis should be made between the afferent and efferent loops of jejunum about 10 cm. (four inches) below the gastro-intestinal anastomosis.

Remarks. We have described posterior gastro-jejunostomy with the use of a long loop because it is important for the surgeon thoroughly to understand the technique of the operation, in order that he may be qualified to treat the complications which sometimes follow its employment. We have ourselves entirely abandoned this form of operation, because we believe that the "no loop" method gives much better and much more certain results; but operations with a "long loop" have been done in the past, and even now any surgeon is liable to be called upon at any time to treat patients suffering from the vicious circle following gastro-jejunostomy by this method, employed a number of years previously, perhaps by another operator. We believe primary entero-anastomosis is always advisable when the long loop method is employed, and think it safer to use the clamps and sutures rather than any appliance such as the Murphy button.

(*B*) *No Loop.* The transverse colon is delivered in the manner already described, and the transverse mesocolon opened, and the posterior wall of the stomach exposed precisely as in the technique employed when a long jejunal loop is used. The clamps, however, should not be applied parallel to the greater curvature of the stomach, since to do so would markedly distort the jejunum, which at its origin runs more or less perpendicularly to the greater curvature of the stomach. Instead, the gastric clamp is to be applied a little obliquely, so that the incision in the stomach will pass from above downward and to the patient's right. Mayo has urged that the incision be made in the other direction, obliquely downward and to the left, claiming that this preserves the normal anatomical relations better, and that the fact of the anti-peristaltic direction of the anastomosis thus effected is of no consequence. But as Moynihan points out, the jejunum is quite freely movable below the ligament of Treitz, and if found

running downward and to the left while patients are on their backs, may also be found running downward and to the right if they are made to lie on their right side. Therefore it seems best to adhere to the method of Petersen, who made the opening in the stomach practically at right angles to its greater curvature, or perhaps inclined a little to the right. Moynihan lays stress on the importance of not rotating the jejunum on its long axis, as this may cause obstruction at the duodeno-jejunal flexure. Latterly we have made the anastomosis with the jejunal loop inclined to the patient's left, and have seen no ill effects from it.

Fig. 60.—Posterior Gastro-jejunostomy with no Jejunal Loop.

The point of emergence of the jejunum from the transverse mesocolon corresponds in most instances very closely to the duodeno-jejunal juncture; but in a small proportion of cases the jejunum is retro-peritoneal for a variable distance from its origin before leaving the posterior parietal peritoneum and becoming invested by the mesentery. Murphy has described a retro-peritoneal position of the primary loop of jejunum, several inches in length, which he claims to have encountered lately in a number of patients. Mayo has also called attention to the occasional presence of a peritoneal fold which passes from the transverse mesocolon for some distance down the jejunum. It is important for the surgeon, therefore, critically to examine the supposed primary coil of jejunum, and to make sure that no abnormality will cause him to perform a long loop operation when he aims to leave no loop at all. If the peritoneal fold described by Mayo is recognized, it should be divided up to its origin in the transverse mesocolon, the raw area left on the jejunum should be inverted by a few sutures, and the anastomosis made close to the true origin of

the jejunum. If the first coil of jejunum be retro-peritoneal, as described by Murphy, it may not be possible to employ it for the anastomosis. Hence the surgeon will be forced to perform a long loop gastro-jejunostomy; and he will do well under such circumstances to safeguard this by an entero-enterostomy as described in the previous section.

In case no abnormality exists, the rubber covered clamps are applied to the posterior gastric wall and to the jejunum, as previously described, except that no loop of jejunum is left; and the anastomosis is completed in the same way. It is important that the anastomosis should be made in the pyloric antrum, so as to allow it to approach as closely as possible in physiological action to the normal pylorus. It is well to bear in mind that, inasmuch as the stomach is turned upside down during the operation, the clamps are to be applied with their axis running from the patient's right shoulder toward his left hip, and not in a direction from his left shoulder to his right hip. With the clamps lying in the latter direction the opening in the stomach will be made obliquely downward and to the patient's left.

After the gastro-jejunal anastomosis has been completed, the margins of the opening in the mesocolon are sutured to the posterior wall of the stomach around the anastomosis, one "anchor suture" is inserted, as described at page 379, and the viscera are then replaced in their normal positions. The great omentum is finally drawn carefully down over the small intestine, and the abdominal wound closed in the usual way.

Posterior Gastro-jejunostomy in-Y (Roux). Deliver the transverse colon, incise the mesocolon, and expose the posterior wall of the stomach, as already described, and apply a rubber covered clamp, in the usual way. Draw out of the abdomen the first coil of the jejunum, and empty it of its contents by manipulation with the fingers for a distance of about twelve inches (30 cm.). Apply a long rubber covered clamp across its lumen in two places, leaving an omega loop of at least ten inches (25 cm.), with its mesentery, hanging free beyond the clamp. Or if it seems undesirable to clamp the entire blood supply for so long a time, the surgeon may employ two smaller clamps, each constricting the entire lumen of the jejunum, about

25 cm. (10 inches) distant one from the other. The proximal point of the jejunum clamped should be about 10 inches (25 cm.) below the duodeno-jejunal juncture. Next divide the jejunum completely across about four inches (10 cm.) below where the clamp compresses its proximal end. This will leave two segments of jejunum within the grasp of the clamp: the proximal segment will be about four inches, and the distal about six inches long. An incision is then made in the portion of the posterior wall of the stomach which is held in the grasp of the other pair of rubber covered clamps, and the pouting mucous membrane is excised. Then the surgeon unites by termino lateral implantation the open circular end of the distal jejunal loop with the gastric incision, applying first a posterior sero-serous suture, then a through-and-through hæmostatic suture, which passes entirely around the anastomosis; and finally the posterior sero-serous suture is resumed, re-inforcing the gastro-intestinal anastomosis on its anterior aspect. Then an incision is made in the distal segment of jejunum opposite the mesenteric attachment, about an inch (2.5 cm.) from the point where it is clamped, and the proximal segment is implanted into this incision, in precisely the same manner (termino-lateral anastomosis) as that in which the jejunum has just been united to the stomach. The clamps may now be removed. If the gastric clamp be removed before the second anastomosis is completed there will be danger of leakage of gastric contents through the lateral incision made in the jejunum for the jejuno-jejunal anastomosis.

Before closing the wound, the structures should be carefully arranged in the abdomen; and the surgeon should not neglect to suture the transverse mesocolon to the stomach around the gastro-jejunal anastomosis.

Exclusion of the pylorus was proposed in 1895 by v. Eiselsberg, and employed by him in four cases. The operation consists in dividing the stomach completely in the pre-pyloric region, closing both ends by suture, and then performing posterior gastro-jejunostomy. Jonnesco prefers this form of operation to a simple gastro-enterostomy, and always employs it when excision (pylorectomy; partial gastrectomy) is impossible. He reports 9 operations by this method during

1906–1907, with 8 patients cured, and one patient dying on the eighth day from hemorrhage from a gastric ulcer.

We have already expressed our preference for simple gastro-jejunostomy instead of excision or partial gastrectomy unless there is a suspicion of the disease being malignant; and we cannot see that this operation of exclusion of the pylorus presents any particular advantages in ordinary cases. When the pylorus is freely patulous, there will be a tendency for the gastric ulcers to heal when the acidity of the gastric secretions shall have been diminished by gastro-jejunostomy; but exclusion of the ulcerated area from the stomach would prevent this change in the gastric secretions having any effect on the ulcers, while at the same time it would subject the patients to very nearly as much danger as would a pylorectomy. Possibly in a patient with tuberculous ulcers of the pyloric region exclusion of the pylorus might be preferable to gastro-jejunostomy were pylorectomy impossible.

GASTROPLASTY.

Gastroplasty, an operation analogous to pyloroplasty, is adopted in certain cases of hourglass constriction of the stomach. This operation is said to have been employed first by Bardeleben, in 1889. The first patient who recovered was operated upon in 1892 by Krukenberg.

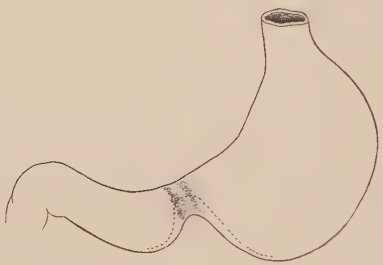

FIG. 61.—DIAGRAM OF INCISIONS FOR (1) GASTROPLASTY; (2) GASTRO-ANASTOMOSIS.

A rubber covered clamp is applied to the stomach, with its axis corresponding to the long axis of this organ, so as to pick up in its grasp a fold of gastric wall forming the channel of communication between the two pouches of the stomach. This fold of gastric wall is then incised down to the mucous coat, which is excised when it pouts into the incision. Hæmostatic or Allis's forceps are then used to grasp the margins of the gastric incision at its extremities and at the mid-point of each of its sides. As these forceps draw the gastric incision well upward, the clamp is loosened, removed, and reapplied at right angles to its former position. As this is done the pairs of forceps formerly at the mid-points of the gastric incision are separated so as to change the formerly longitudinal incision into a transverse wound, while the forceps formerly at the ends of the incision will now be attached to its sides. The rubber covered clamp having been reapplied, the gastric incision is closed by a through-and-through

FIG. 62.—GASTROPLASTY.

hæmostatic suture of iodized catgut, which is afterward reinforced by a continuous Lembert suture of linen. The rubber covered clamps should be loosened as soon as the through-and-through suture has been completed, to test its hæmostatic effect; and, as in other operations, any bleeding points should be controlled by separate sutures.

GASTRO-GASTROSTOMY.

Gastro-gastrostomy, an operation first employed in cases of hour-glass stomach by Wölfler in 1894, consists in making a lateral anastomosis between the adjacent parts of the gastric pouches. Two rubber covered clamps are applied to the stomach, one in the cardiac, the other in the pyloric pouch, lying parallel to each other and trans-

FIG. 63.—GASTRO-GASTROSTOMY.

FIG. 64.—GASTRO-ANASTOMOSIS.

verse to the long axis of the stomach. The usual technique of lateral anastomosis by suture is followed. The opening should be at least three inches long. If the form of the constriction prevents so large an anastomosis, some other operation should be employed.

GASTRO-ANASTOMOSIS.

Gastro-anastomosis. This term may be used to designate an operation for hour-glass stomach analogous to Finney's pyloroplasty, introduced in 1903 by Kammerer. Clamps may be used for this operation, which differs from gastro-gastrostomy only in that the incisions meet, becoming continuous one with the other through the anterior wall of the channel connecting the two gastric pouches.

GASTRO-PLICATION.

Gastro-plication. This operation, proposed in 1891 by Bircher, is now usually done by Moynihan's modification of Bennett's method. Interrupted Lembert sutures are placed in the anterior gastric wall, each suture picking up this structure in four or five places, and running

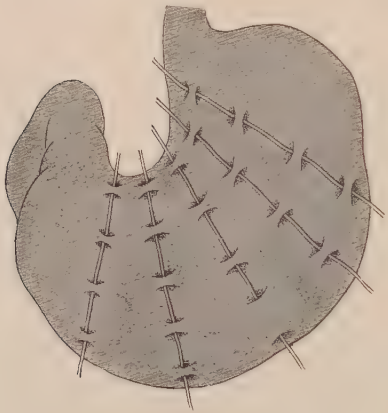

FIG. 65.—GASTRO-PLICATION.

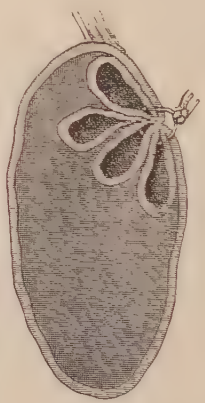

FIG. 66.—GASTRO-PLICATION, SEEN IN SAGITTAL SECTION.

from the greater to the lesser curvature, transversely to the long axis of the stomach. As these sutures are tightened, the anterior wall of the stomach is puckered up, and the curvatures approach each other, thus diminishing the capacity of the stomach.

GASTROPEXY.

Gastropexy, an operation designed to fix a proptosed stomach, may be performed by either Duret's or Beyea's method.

(1) Duret's Method. The abdomen is opened through the left rectus muscle, but the parietal peritoneum in the upper portion of the wound is not divided. By interrupted or continuous Lembert sutures

of linen the anterior gastric wall is sutured to the parietal peritoneum of the epigastric region. The sutures should be inserted near the lesser curvature of the stomach, and should include not only the peritoneum of the abdominal wall but also the muscle and overlying fascia. They should not, however, pass through the skin, as it is desirable that they should remain permanently.

(2) Beyea's Method. Interrupted sutures of linen are passed through the gastro-hepatic omentum from the stomach up to the under surface of the liver; each suture picks up the lesser omentum in four or five places. As these sutures are tightened the lesser curvature of the stomach is drawn up against the liver by the puckering of the gastro-hepatic omentum. Care should be taken not to puncture any blood-vessels in this structure.

GASTRECTOMY.

Gastrectomy. The terminology employed by writers with regard to excision of portions of the stomach is not always uniform, and unless the terms used are clearly defined confusion is liable to arise. In the present work we employ the following terms to designate the operations denoted below. *Sphincterectomy*: By this we understand the removal merely of the pyloric sphincter, with end-to-end reunion of the duodenum and the stomach. It is an operation which in a few rare instances has been employed for benign fibrous stenosis of the pylorus, in which the pre-pyloric portion of the stomach was healthy. Pyloroplasty, we think, would be a less dangerous and quite as satisfactory an operation. By *Pylorectomy* we mean removal of the pylorus; it is a more extended resection than sphincterectomy, but less so than partial gastrectomy, in which latter operation the entire lesser curvature of the stomach is removed. It is not always possible during an operation to determine the precise limits of the pyloric antrum; but, in general, we mean by *partial gastrectomy* an operation which removes besides the pylorus, also the neighbouring part of the stomach as far as the Hartmann or Mikulicz line, always including the whole of the lesser curvature. If the gastric area removed extends still further toward the fundus along the greater curvature, we speak of the operation as *subtotal gastrectomy;* while the term *total gastrectomy* is reserved for operations which leave behind no portion of the stomach, the upper section passing through the lower end of the œsophagus, while the lower section of course divides the duodenum. *Circular* or

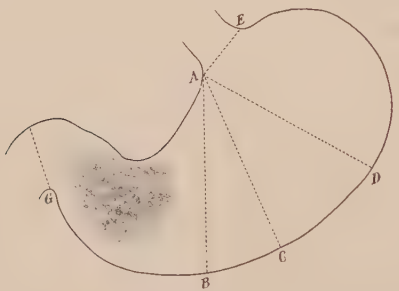

Fig. 67.—Diagram Showing Various Incisions for Gastrectomy.

G, Duodenal section; *AB*, Hartmann line; *AC*, Mikulicz line; *AD*, Mayo line; *AE*, total gastrectomy.

cylindrical gastrectomy designates an operation by which the central portion of the stomach is removed, neither the pylorus nor the fundus being included in the section, although the lines of division extend from one curvature to the other and involve the entire circumference of the stomach. By *gastric resection* we understand removal of a portion of the stomach not including the entire lumen of the organ; the term *plastic resection* we think therefore properly describes the operation called gastroplasty by Jedlicka; since in this operation, after resection of a portion of the anterior wall of the stomach, he reconstructs the organ by a plastic operation. *Excision* in connection with gastric operations we would limit to the removal of more or less circumscribed lesions or pedunculated tumors attached to or springing from the stomach.

As many of these operations are always *atypical* it is not possible to describe them in detail. It being well appreciated that every surgeon of experience developes a technique more or less peculiar to himself, and that all that can be asked in a work of this kind is an adequate description of certain *typical* operations, we have selected the following for discussion: I. Pylorectomy, by Billroth's first method. II. Partial Gastrectomy, including Kocher's method, and Billroth's second method. III. Total Gastrectomy. IV. Cylindrical Gastrectomy. V. Gastric Resection.

The **indications** for the employment of gastrectomy have been discussed in previous chapters (pp. 116, 298).

Pylorectomy by Billroth's First Method. This operation was first performed by Péan in 1879, then by Rydygier in 1880, and first successfully by Billroth in 1881.

Open the abdomen by an incision four or five inches (10 to 12 cm.) long, close to the median line, through the right rectus muscle. Place sufficient gauze packs in the lower part of the wound to keep the small intestines and transverse colon from protruding. Identify the stomach, and doubly ligate the coronary artery on the lesser curvature at the site selected for the gastric section, and cut the artery between the ligatures. Doubly ligate the gastro-epiploic artery on the greater curvature at the other extremity of the proposed section, and divide it between the ligatures. Ligate in sections, by means of an aneurism

needle, the gastro-hepatic and the gastro-colic omenta, from the line of the proposed section in the stomach to the duodenum. At the greater curvature this row of ligatures should pass between the gastro-epiploic artery and the transverse colon, great care being exercised not to include the middle colic artery in any of the ligatures. The lesser omentum should be ligated fairly close to the liver. Thus all enlarged glands will be removed in one piece with the stomach.

Pass a gastrectomy clamp, with rubber sheathed blades, from the greater to the lesser curvature, at the site of the proposed section of the stomach. Bring its points out far enough beyond the lesser curvature to grasp firmly between the blades the whole of the proposed section of the stomach. Parallel to this first clamp pass a second on the pyloric side of the gastric section, about one inch distant from the first clamp. The latter clamp need not have its blades covered with rubber. Pass a hot moist sterile gauze pack across the lesser peritoneal cavity from one curvature of the stomach to the other, immediately beneath the two clamps already placed. Then divide the stomach with the scalpel or the actual cautery from one curvature to the other, between the two clamps, but close to the clamp on the pyloric side of the section, so as to leave enough tissue protruding from the rubber covered clamp to make the application of sutures easy. Turn the pyloric portion of the stomach thus set free over to the patient's right, and place sufficient gauze behind the stomach and pylorus to protect thoroughly the lesser peritoneal cavity. Having thus mobilized the pyloric portion of the stomach, it will be easy to detect the pyloric artery on the lesser curvature, and the beginning of the right gastro-epiploic artery on the greater, just below the pylorus. It is not necessary to ligate the gastro-duodenal artery above the pylorus; to do so might impair the blood supply to the descending duodenum and the head of the pancreas. When the pyloric and right gastro-epiploic arteries have been ligated, a rubber covered clamp is to be applied to the first part of the duodenum, and the pyloric part of the proposed duodenal section is to be guarded by another clamp. Close to this latter the duodenum is next divided by scalpel or actual cautery, and the diseased part of the stomach including the pylorus is removed.

The gastric segment will now present a much larger area than the duodenal. Hence the surgeon should begin his through-and-through sutures at the lesser curvature of the gastric segment, and close this portion of the stomach from above downward until the unsutured portion presents the same calibre as does the duodenum. The latter is then drawn across to the gastric segment and united to its unsutured portion first by a posterior sero-serous continuous suture of linen; then the through-and-through (iodized gut) suture is resumed, and the duodenum united to the stomach throughout the circumference of the bowel, great care being exercised to secure accurate approximation at the point where the suture line of the gastric section meets the gastro-duodenal anastomosis. This point of junction is known as the "deadly angle" from the frequency with which leakage has occurred there. When the duodenum and stomach are thus united securely by a through-and-through suture, the gastric and duodenal clamps are removed, and any bleeding points reinforced by specially inserted sutures. Finally the entire line of sutures, both that of the gastric segment and that of the anastomosis, should be inverted by a continuous sero-serous suture. The gauze packs may now be removed; the remains of the gastro-hepatic and gastrocolic omenta are stitched to the upper and lower portions of the anastomosis, and the abdominal wound is closed.

Partial Gastrectomy.—(1) **Kocher's Method.** In this operation the distal segment of the divided duodenum is implanted (terminolateral anastomosis) into the posterior wall of the stomach, a little to the left of the gastric section which is entirely closed. Kocher uses crushing forceps in this operation, instead of the rubber covered clamps employed by most surgeons; he makes the section of the stomach close to the crushing forceps, and as a consequence it is necessary for the through-and-through sutures to be applied on the cardiac side of the crushing forceps. Then when these forceps are removed, the projecting tissue is trimmed close to the line of the through-and-through sutures, and the latter are inverted by a running sero-serous suture. The following description of the operation is taken from the English translation by Stiles of Kocher's Operative Surgery (London, 1903, p. 215).

"After ascertaining exactly the limits of the tumour, and the mobility and the possibility of separating glands, the lesser omentum and the gastrocolic ligament are perforated at the margin of the new growth towards the fundus of the stomach, and two large pressure-forceps are applied quite close to each other, and closed as firmly as possible. After gauze pads have been placed beneath the forceps (the aseptic protecting pads have previously been placed round the parts outside the abdomen) the stomach is cut across between the two clamps, close up to the one to the right. According to Hartmann's rule, and on the grounds of Cunéo's observations, the clamps must be applied to the lesser curvature as high up and as much to the left as possible; and in order that the glands that accompany the coronary vessels may at the same time be removed, it appears to us advisable to double ligature and cut across the coronary artery above the point where the section is to be made. By dividing bloodlessly the small omentum above the glands the divided stomach is rendered so movable that it can be turned over to the right side.

"Hartmann places value on the last procedure because the fatty tissue and glands can then be followed up along the lesser curvature and can be included in the removal as far as the origin of the pyloric and the gastroduodenal branches of the hepatic artery. The latter vessel is carefully avoided, while the two first named are ligatured. After throwing the stomach over towards the right margin of the wound, one sees quite well the gastroduodenal artery running downwards in the groove between the duodenum and pancreas. In this way no bleeding should occur in detaching the chain of glands which accompany this artery along the above-mentioned groove. We can manage quite well without ligaturing the artery. Throwing the stomach over to the right edge of the wound has the advantage that by drawing upon it the duodenum is rendered quite accessible from behind, so that the limits of the new growth can be ascertained with certainty, and one can determine if the duodenum be long enough and movable enough to enable one to perform gastroduodenostomy. When this is the case, two small pressure-forceps are now applied to the duodenum, which is cut across between them with the knife close up to the pair farther removed from the stomach, a small pad of

gauze having previously been placed under the part. The cut edges are then carefully and thoroughly cleansed.

"The opening can now be made into the stomach before closing it with sutures, because the forceps in position afford a very good support. A pair of clamp-forceps is applied to the duodenum and the accompanying vessels, and the crushing-forceps are removed. The fingers of the assistant can now grasp the stomach so that the anterior wall is pressed against the posterior wall at the place where the incision has been made; or a pair of clamp-forceps may be applied to the stomach after it has been closed by suturing and before the incision is made for anastomosis with the duodenum.

"A continuous mattress suture, after the manner of a half Gély's suture, is carried close behind the crushing-forceps (which has not been removed from the stomach); only the commencement is knotted, and by pulling on the two ends reliable closure is effected. If the crushing-forceps are not strong enough to compress the tissues so that they are like thin dry paper, it is desirable that every projecting portion of mucous membrane and muscular pulp should be clipped away with scissors, but this is unnecessary if sufficiently powerful compression (crushing) forceps are employed. With the ends of the suture held taut, a continuous glover's suture is rapidly applied over it so as to fix each loop, and the closure is completed by inverting both by a continuous serous suture.

"The stomach and duodenum are now clamped at some distance from the place where they have been opened, or are to be opened, and the crushing forceps are removed from the duodenum. Escape of the contents being carefully prevented, an incision is made into the posterior wall of the stomach near the greater curvature at a distance of 3 cm. (about one inch and a quarter) from, and parallel to, the sutures which close it, at first merely through the serosa, for a length equal to the breadth of the duodenum. The posterior segment of the circular suture is now applied. The wall of the stomach is then completely cut through and a continuous suture, passing through all the coats, is applied so as to unite the posterior edges of the opening in the stomach and duodenum. A third continuous suture is applied so as to unite the two mucous edges. The anterior edges are now united by a con-

tinuous suture which passes through all the coats, and is knotted at each end to the posterior suture. The clamp-forceps, if such have been employed, are removed, and lastly, the anterior serous suture is applied and knotted at each end with the posterior serous suture."

Remarks.—The technique employed by Kocher, as is seen from the above description, closely follows that originally worked out by Hartmann, in that the stomach is divided before the duodenum, is then turned to the patient's right, and the duodenal section made after clearing the glands away from along the gastro-duodenal artery. The particular part of the operation by virtue of which Kocher's name has been attached to it, consists in the implantation of the duodenum into the posterior wall of the stomach. If the removal of the stomach has been at all extensive, it is very likely that it will be impossible to bring the duodenum and stomach into apposition, even after mobilizing the duodenum. In such circumstances gastro-jejunostomy should be done.

(2) **Billroth's Second Method.**—This method, in which the operation is terminated by a gastro-jejunostomy, is that which we prefer to employ in all cases. Usually the anastomosis should be made in the posterior wall of the stomach; but if the patient's condition is bad, or if the remaining portion of the stomach is very small, anterior gastro-jejunostomy, as done by Billroth himself, may be adopted. The use of a Murphy button may hasten the procedure in desperate cases.

The technique habitually employed at the German Hospital is the following:

After exposing the stomach, the coronary artery is identified, doubly ligated and divided, close to the cardiac orifice of the stomach. The finger is passed through the gastro-hepatic omentum into the lesser peritoneal cavity, and the gastro-hepatic omentum is ligated in sections, fairly close to the transverse fissure of the liver. By cutting through the gastro-hepatic omentum, the surgeon reaches the pyloric artery, which is doubly ligated and cut. The finger is then passed down behind the pylorus, and the right gastro-epiploic artery is identified below the pylorus; this artery is ligated, but is not cut. Hæmostatic forceps are then applied to the gastrocolic omentum, and as

they are applied this structure is divided between them, beginning at the pylorus and passing along the upper border of the transverse colon until the point is reached at which it is proposed to divide the stomach. This point should be two inches to the left of the visible malignant

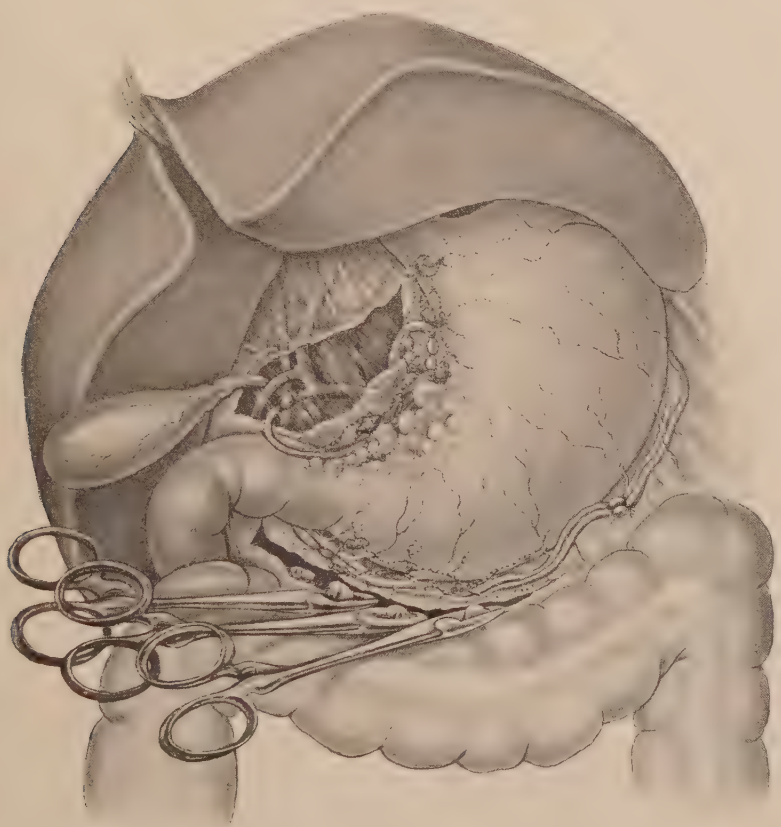

Fig. 68.—Partial Gastrectomy: Division of Gastro-colic Omentum.

growth. When this point has been reached, the left gastro-epiploic artery is ligated just to the left of the proposed gastric incision. In placing the hæmostats on the gastro-colic omentum, great care is to be taken to avoid the middle colic artery and its branches (Fig. 68).

The portion of stomach to be removed is now completely freed

along its curvatures, and remains attached only to the duodenum and the body of the stomach. The lesser peritoneal cavity can now be protected thoroughly by sterile gauze compresses. A clamp with rubber-covered blades is now applied to the duodenum about one inch beyond the portion visibly diseased, and an ordinary clamp is applied just to the pyloric side of the first clamp. The duodenum is

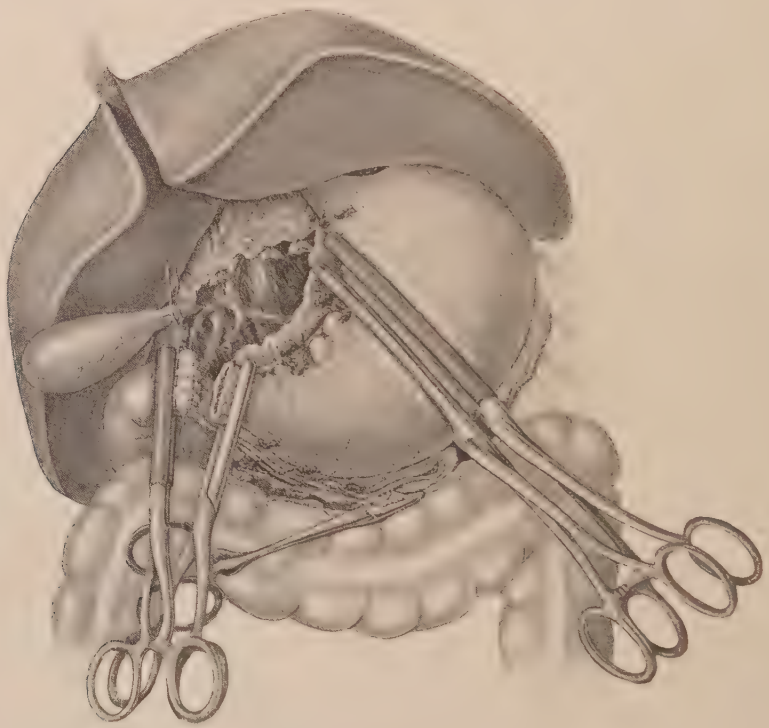

Fig. 69.—Partial Gastrectomy: The Duodenum has been Divided, and the Clamps are in Place for the Gastric Section.

then divided between the two, the section cutting also the right gastro-epiploic artery (already ligated) below the pylorus. The entire portion of the stomach to be excised can now be turned to the patient's left. The duodenal stump is closed first by a through-and-through iodized catgut suture; before the occluding clamp has been removed a purse-string suture of linen is applied on the distal (duodenal) side

of the clamp; the clamp is then removed, and by catching the duodenal wall in two places with dissecting forceps, the sutured end of the duodenum is inverted and the purse-string suture is drawn tight and tied. Sometimes a few additional Lembert sutures of linen are inserted to re-inforce those previously placed. As the duodenum is divided where part of its wall is retroperitoneal, it is very important to

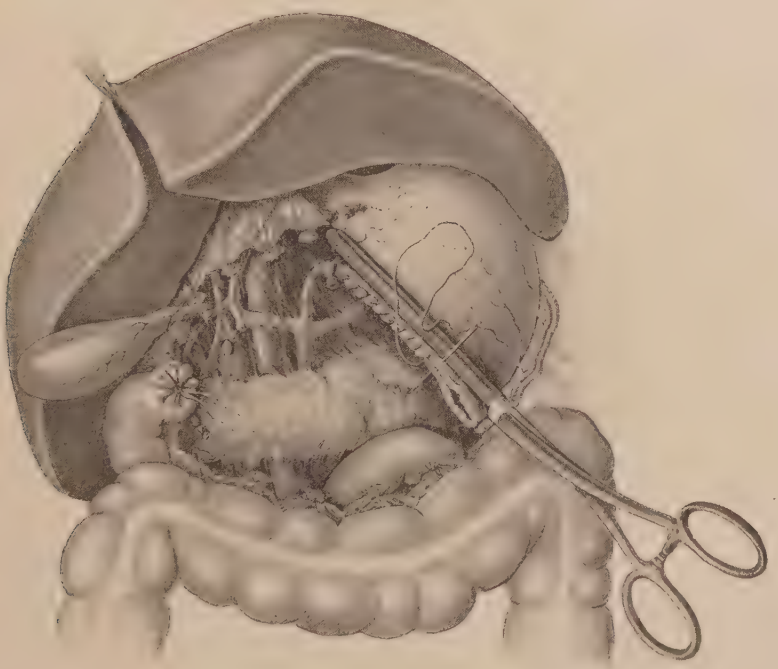

Fig. 70.—Partial Gastrectomy: Through-and-through Sutures being Applied to the Gastric Section.

suture it accurately; but usually the through-and-through suture and the purse-string suture are all that is necessary. The gastro-colic omentum is then ligated, and the hæmostatic forceps removed.

Rubber-covered gastrectomy clamps are then applied across the stomach from the greater to the lesser curvature, at least two inches to the left of the visible malignant growth (Fig. 69). Clamps with

a screw lock at the end of the blades, as in Kocher's clamps, are safest. The entire lesser curvature is always removed, but the line of the section passing from that point to the greater curvature varies with the extent of the tumor. About three-fourths of an inch to the right of

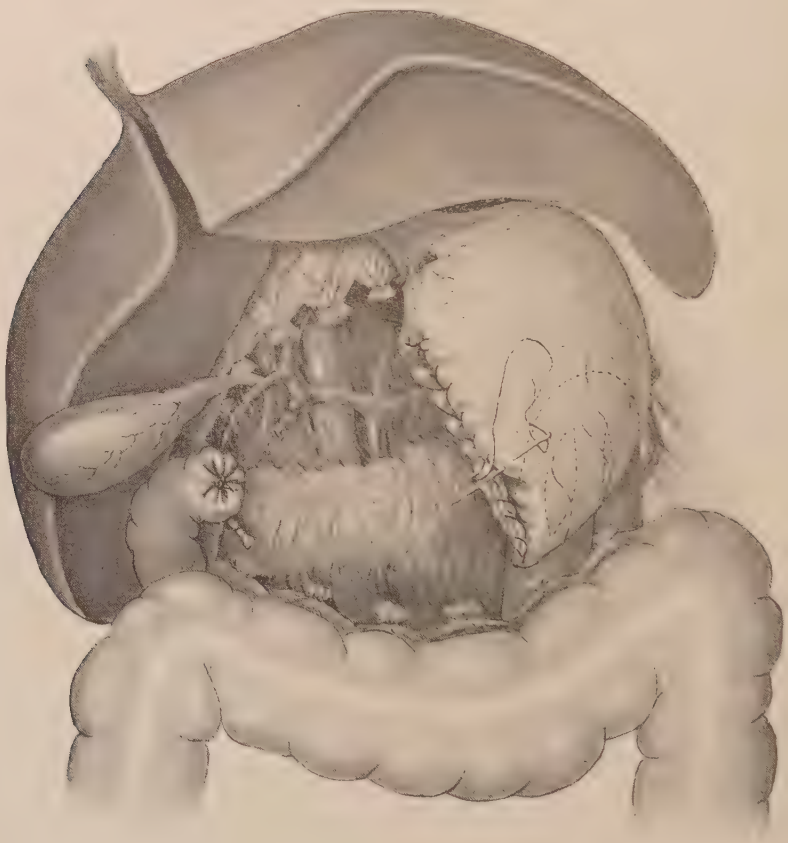

Fig. 71.—Partial Gastrectomy: Sero-serous Sutures being Applied to the Stomach.

this occluding clamp, an ordinary forceps is applied, and the stomach is divided between the two with the Paquelin cautery. The excised portion being removed, a through-and-through suture of iodized catgut is inserted through the margins of the gastric walls which protrude from

between the blades of the rubber-covered clamp (Fig. 70). It is well to grasp these margins at one or more points with forceps to prevent their retracting. When the through-and-through sutures have been completed, the clamp is removed, and a continuous sero-serous suture is applied, burying the first row, and carefully re-inforcing any points that tend to bleed (Fig. 71).

The transverse colon is then drawn out of the wound, and the posterior gastric wall is exposed by opening the transverse mesocolon. A posterior gastro-jejunostomy is then done by the usual technique, as described at page 381, and as indicated diagrammatically in Fig. 71.

Finally, after suturing the mesocolon to the posterior gastric wall, and replacing the newly formed anastomosis within the abdomen, the great omentum is drawn up to cover the space left by the removal of the stomach, and the abdominal wound is closed.

Subtotal gastrectomy differs from partial gastrectomy only in the extent of the stomach removed. A precisely similar technique may be employed. In some cases, however, there will be so small a portion of the cardia left that only an anterior gastro-jejunostomy can be done.

Remarks.—It is seen that the technique of partial gastrectomy as above given is practically identical with that described by Mayo in 1904. Although the technique of Hartmann, in which the gastric section is made first, and the tumor then turned to the patient's right, before dividing the duodenum, presents the undoubted advantage of approaching the dangerous retro-pyloric region in an open and strictly anatomical way, yet it has the disadvantage, as pointed out by Mayo, of being less easy of accomplishment than the method in which the duodenum is divided first; because the line of proposed section of the stomach is frequently difficult of access until the stomach is mobilized by section of the duodenum. We would point out, moreover, that Mayo's operation has the distinct advantage that the occluding clamps are not applied to the stomach until the last possible moment, and that they are kept in place for the very shortest possible time—in fact, only until it is possible to insert the through-and-through sutures. There is thus scarcely any risk of interference with the vascular supply of the sutured edges.

Total Gastrectomy.—In rare cases after the abdomen has been opened it may be found that the disease has invaded so great an area of the stomach as to render its entire removal desirable, while at the

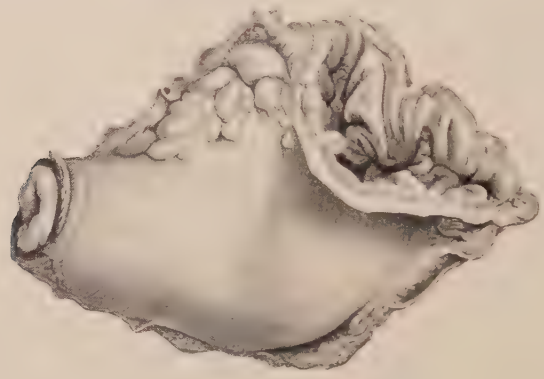

FIG. 72.—PORTION OF CARCINOMATOUS STOMACH REMOVED BY PARTIAL GASTRECTOMY. HALF NATURAL SIZE. (*From a patient in the German Hospital.*)

same time no secondary growths or adhesions exist which will render such an operation impracticable.

FIG. 73.—SPECIMEN SHOWN IN FIG. 72 SPLIT OPEN THROUGH PYLORUS. HALF NATURAL SIZE.

The operation should proceed along the same lines as partial gastrectomy, until the duodenum has been divided. It is then to be determined whether the duodenum can be made to reach the œsoph-

agus without undue tension. Mobilization of the duodenum, as in operations on the retro-duodenal portion of the common bile duct, may render this possible. If the duodenum can be made to reach the œsophagus, it should be attached to the latter by a primary posterior row of sutures before the cardiac orifice of the stomach is divided. Then the cardia is clamped, divided above the clamp, and the union of the duodenum to the œsophagus completed, an end-to-end anastomosis being performed in the usual way. If the duodenum cannot be made to reach the œsophagus, a coil of the upper jejunum, provided with a long mesentery, should be selected; the jejunum should be divided completely across, its distal end being united to the œsophagus by circular (end-to-end) anastomosis, and the proximal end being implanted into the distal segment at a convenient distance below the œsophago-jejunal anastomosis. The jejunum should be united to the œsophagus by the trans-mesocolic route if possible. The Murphy button may be employed if accurate suturing is impossible.

Should the surgeon be so heedless as to remove the entire stomach before determining whether any portion of the intestinal tract can be anastomosed to the œsophagus, he should suture the divided end of the duodenum into the abdominal wound; should this be impossible, jejunostomy may be a last resort.

It might be possible to connect the œsophagus and duodenum by an excluded loop of the jejunum, transplanted through the transverse mesocolon, somewhat after the manner of Herzen's operation of gastrostomy.

Vassalo reports a case of total gastrectomy in which the entire time consumed in the operation was only thirty-eight minutes.

CYLINDRICAL GASTRECTOMY.

Cylindrical Gastrectomy.—This operation is suitable only for benign lesions occupying the middle zone of the stomach. If there exist an ulcerated area which does not obstruct either orifice of the stomach, as is the case with some ulcers along the lesser curvature; and if some form of radical operation is to be preferred to gastro-jejunostomy, then a cylindrical gastrectomy frequently will be simpler

and easier of accomplishment than resection of a V-shaped area from the lesser curvature. In some cases of hour-glass stomach cylindrical gastrectomy may be of benefit.

We entirely agree with Leriche, however, in his dictum that cylindrical gastrectomy is absolutely contra-indicated if there are enlarged glands in the gastro-hepatic omentum; but we would go further, and prohibit its employment in *every* case of malignant disease, because under such circumstances the entire lesser curvature should be removed. Leriche, who is a supporter of excision of benign lesions in general, makes the bold but possibly significant statement that if this operation were more often done for non-stenosing cancer, more cases of progressive pernicious anæmia would be cured.

The operation may be performed thus: After exposing the stomach and ligating the main arteries at the extremities of the proposed sections, two pairs of rubber-covered clamps are applied, including between them the portion of stomach to be removed, which should be emptied as completely as possible before tightening the clamps. The gastro-colic and gastro-hepatic omenta are next ligated, and divided. The diseased portion of the stomach is then cut away, and the divided surfaces of the stomach united by circular gastrorrhaphy (end-to-end anastomosis). Leriche calls attention to the advantages of commencing and terminating the continuous sutures, not at one of the curvatures of the stomach, where the peritoneal coat is defective, but at some convenient point on the anterior gastric wall. If the two portions of the stomach do not meet with the utmost facility, that is to say, if there be the very least tension on the sutures anywhere, it will be possible to overcome this by *mobilization of the duodenum.* In some cases it may seem better to terminate the operation as in *exclusion of the pylorus*, by closing both gastric segments and doing a separate gastro-jejunostomy.

GASTRIC RESECTION.

Gastric Resection.—Removal of a *wedge-shaped area* from the lesser curvature of the stomach may be accomplished by applying rubber-covered clamps outside of the proposed lines of section, after

tying off the gastro-hepatic omentum. The wounds left may then be sutured the one to the other, thus approximating the cardiac and pyloric orifices. This mode of reunion may prove difficult or even impossible; under which circumstances a complicated form of plastic operation may have to be undertaken. This operation, therefore, is not one to be lightly undertaken; indeed we cannot see that it presents any advantages over cylindrical gastrectomy. Jedlicka has adopted a form of *plastic resection* of the stomach which he calls *gastroplasty*. By this operation, after removing the diseased portion of the lesser curvature and of the anterior or posterior walls of the stomach, he reconstructs the natural contour of the stomach by the method of sliding flaps. In one case the operation took two hours and a quarter.

Resection of the cardia, founded on the advances in thoracic surgery inaugurated by Sauerbruch and by Brauer, has been accomplished in one case of carcinoma by Wendel with the use of Brauer's positive pressure air chamber around the patient's head. He operated on Sept. 6, 1906, making an incision six inches and a half (16 cm.) long in the sixth left costal interspace, cutting through the seventh costal cartilage. Some adhesions between the lung and pleura were separated, and the lung was excluded from the field of operation by the use of gauze packs. The vagi were then freed without difficulty, the lower end of the œsophagus isolated, and gauze was passed behind it. The œsophagus was then freed from the diaphragm. This work was absolutely in the dark, and accomplished only by the sense of touch; it was very difficult; there was free arterial bleeding, and the bleeding points were very difficult to ligate. The time consumed was now an hour and a half. It was found impossible to do an anastomosis between the œsophagus and the stomach to one side of the tumor, so resection was undertaken. The tumor could be drawn out through the diaphragm and across the pleural cavity, even to the thoracic wound. It was surrounded by gauze packs. The vagi were found entering the tumor and could not be dissected free lower down. They were therefore cut off 1 cm. (less than half an inch) from their point of entrance into the tumor. The œsophagus was next divided, and its end closed by sutures. Before

this was done, however, the male half of a Murphy button was inserted into the œsophagus, and later was liberated by making a slit in the side of the latter. The gastric incision included practically all of the lesser curvature, and a good deal of the fundus of the stomach. The female half of the button was passed into the cavity of the stomach through the gastric wound, which was then completely closed, the shank of the button being made to protrude at another point of the gastric wall, where it was exposed by a puncture, and the two halves of the button approximated. Finally the margins of the diaphragmatic incision were sutured to the stomach below the anastomosis, and the intercostal wound was closed, with a strip of gauze for drainage. The time of the entire operation was somewhat over two hours. Although the patient reacted well, death occurred suddenly the next morning from secondary hemorrhage. The bleeding was found to come not from the line of sutures, but probably from one of the vessels which had been so difficult to ligate.

A similar operation had been done previously, and with success, several times on dogs, by Sauerbruch and by Sencert, and it had been attempted in two cases by Sauerbruch on man, but the patient in whom resection was attempted died on the table, and in the other the tumor was found to be inoperable, and an œsophago-gastric anastomosis was done, the patient dying in 24 hours.

Wiener, in a patient with carcinoma of the lesser curvature of the stomach invading the cardia, employed osteo-plastic resection of the costal arch, under gas and ether anæsthesia, and thirty days later, under spinal anæsthesia, excised the growth, doing œsophago-gastrostomy. Death occurred in eleven days, and was found to be due to a subphrenic abscess occasioned by separation of the œsophago-gastric anastomosis. Wiener suggests doing a cervical œsophagostomy of the lower end of the œsophagus, and a gastrostomy, instead of attempting to unite the œsophagus and stomach.

JEJUNOSTOMY.

Jejunostomy.—This operation was first employed in 1878 by Surmay, of Ham, in the case of a patient with carcinoma; death occurred the next day, from peritonitis.

Karewski adopted the *method of Witzel* for gastrostomy. A coil of the jejunum about 45 cm. (18 in.) from its origin is selected, and the catheter is sutured in place, as shown in Fig. 74, with its eye

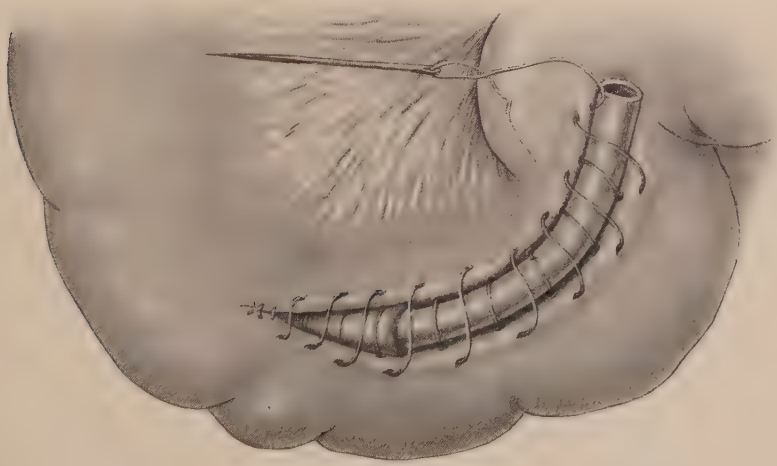

Fig. 74.—Jejunostomy by the Method of Karewski.

end toward the anal end of the bowel. Then the bowel is attached to the parietal peritoneum at the edges of the abdominal incision, and the latter is sutured close up to the tube. Feeding should be begun at once.

In Maydl's operation the jejunum is completely divided about 20 cm. (8 inches) below its origin, the proximal segment is implanted (end-to-side anastomosis) into the distal about 20 to 30 cm.(8 to 12 in.)

below the section, and the distal segment is sutured end-on into the abdominal wound (Fig. 75).

Duodenostomy, in which the fistula is made (after the method of Witzel and Karewski) in the duodenum above the bile papilla, is preferred to jejunostomy by Hartmann.

Fig. 75.—Jejunostomy in Y. Method of Maydl.

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CHAPTER XV.

COMPLICATIONS AND SEQUELS.

The operations which are now employed in the treatment of gastric diseases are much less frequently followed by untoward symptoms than was the case in the earlier periods of the surgery of the stomach. Yet certain complications and sequels still demand attentive study by the surgeon, because even now a patient is occasionally seen who has been operated on by an antiquated method, and who presents the symptoms of one of the sequels formerly not unusual. Moreover, there are certain complications and sequels which are due to the original disease, and not to the operative treatment: these will always deserve careful consideration.

The main subjects to be considered in this chapter are:

1. The Causes of Death after Operation, including Shock, Peritonitis, and Pneumonia.
2. The Vicious Circle after Gastro-jejunostomy.
3. Peptic Ulcer of the Jejunum after Gastro-jejunostomy.
4. Internal Hernia.
5. Gastric Fistulæ.
6. Duodenal Fistulæ.
7. Subphrenic Abscess.

1. The Causes of Death after Operation.—The chief of these are Peritonitis, Pneumonia, Shock, and the Vicious Circle. Unfortunately most writers, while narrating their successes in glowing terms, have not dwelt particularly on the details of their fatal cases, giving only general expressions of opinion as to the most frequent cause of death.

Among 92 operations for benign diseases of the stomach, done by Dr. Deaver at the German Hospital,* the records of which were

* It is much to be regretted that many operations done by Dr. Deaver in other hospitals, and at the patients' homes, cannot be included, owing to lack of details.

analyzed for us by Dr. Whiting, there were 8 deaths. In two patients (Nos. 1 and 8), one operated on in 1900, the other in 1903, the cause of death is not noted in the records. Death was attributed to exhaustion in one patient (No. 47), referred to at page 111, who was almost exsanguinated from repeated hemorrhages before operation, but lived for forty-eight hours afterward. Two patients (Nos. 7 and 27), one in 1902, the other in 1905, died of peritonitis, which was in each instance due to leakage of the Murphy button employed in doing an entero-anastomosis for vicious circle some days after the primary operation (posterior gastro-jejunostomy with a long afferent loop). One patient (No. 20), operated on in 1904, died from the effects of the vicious circle following the posterior "long loop" operation, relief not being obtained from a secondary operation in which the distended afferent loop was resected with end-to-end anastomosis. One patient (No. 82) with phthisis died of œdema of the lungs developing on the eighth day after the operation; and one patient (No. 67), with subacute perforation of a gastric ulcer, died three weeks after operation from nephritis and myocardial disease.

It is true that in some of these patients the operation itself cannot be held directly responsible for the fatal termination; but nevertheless it is probable that six of the patients would not have died quite so soon had no operation been undertaken. The patient with hemorrhages, who lived two days after operation, and the patient with the perigastric abscess and diseased heart and kidneys would almost certainly have died as soon as they did, if not indeed sooner, had no operation been employed.

Among 46 operations by Dr. Deaver at the German Hospital for carcinoma of the stomach, there were 13 deaths.

Among 31 gastro-jejunostomies—

1 death was due to *shock*, the patient dying in a few hours.

3 deaths were due to *exhaustion*, the patients dying after intervals of 12 days, 15 days, and 7 days, respectively.

1 death was due to *heart failure*, on the 7th day.

1 death was due to *uræmia*, on the 3d day.

4 deaths were due to *peritonitis*, after 4 days, 6 days, 11 days, and 15 days, respectively.

Among 14 partial gastrectomies—

1 death was due to *shock*, the patient dying in 1½ hours.

2 deaths were due to *peritonitis*, after 13 days and 3 days, respectively.

Graf has recently tabulated the causes of death in 7 patients among 86 operated on by Helferich. These may be of interest when compared with the figures just given.

3 deaths from *hæmatemesis* persisting after jejunostomy.

2 deaths from *shock*.

1 death from *anæsthetic*.

1 death from *pneumonia*.

There were five other patients who developed pneumonia or bronchitis after the operation, but these all recovered. There were no deaths attributable to peritonitis or to the vicious circle.

The subject of the Vicious Circle after gastro-jejunostomy deserves a section to itself. It will be sufficient here to refer rather briefly to the subjects of shock, pneumonia, and peritonitis, complicating and following operations on the stomach.

Shock is chiefly due to undue prolongation of the operation on the surgeon's part, or to pre-existing cachexia on that of the patient. It is the surgeon's duty, so far as in him lies, to select that form of operation the unavoidable shock of which that patient will be able to withstand. Ability to so select this operation comes to the surgeon as the result of experience, and is with difficulty learned from a text-book. It should, however, be the surgeon's desire always to aim in the direction of safety, remembering that excellent motto "*primum non nocere*." In the case of very weak patients even an exploration may seem contra-indicated; in others, gastrostomy, jejunostomy, or even gastro-enterostomy can be performed, and a radical operation, when indicated, may be postponed until some strength shall have been gained by forced feeding.

When the operation has once been undertaken, the actual technique of its performance will influence very materially the developement of shock. We always lay great stress on maintaining the natural heat of the body. To this end the patient should wear a jacket of cotton wadding, and his lower extremities should be similarly clothed.

In addition to these precautions, there has been in use for several years at the German Hospital a hot-water bed which covers the entire top of the operating table. These measures joined to the tonic treatment to which the patient has been submitted during the day or so immediately preceding the expected operation, will in the vast majority of cases prevent the occurrence of shock. Indeed, recently we have observed that patients recover as blithely from even extensive gastrectomies as they do from an "interval" operation for appendicitis. When the bodily heat is thus maintained, and when the surgeon eventrates no viscera except those immediately concerned in the operative procedure, the actual duration of the operation seems to have little tendency to produce shock, at least in the case of chronic lesions. Five minutes more consumed in an operation will very rarely be prejudicial to the patient, and will certainly enable the surgeon to do the operation more thoroughly, and therefore with more prospect of ultimate success, than if he is continually trying to establish a record. We regard thirty minutes as a short time to spend in doing a gastrojejunostomy, and are not at all ashamed of taking more than twice as long in difficult cases of gastric surgery.

Hemorrhage predisposes to shock. The surgeon, however, who pursues a definite plan in his gastric operations, and has the necessary acquaintance with the anatomy of the parts, is not apt to encounter uncontrollable hemorrhage. Indeed, in all typical operations there should be no bleeding, as every blood-vessel is clamped or tied before it is divided. Yet where the adhesions are very dense, and where the anatomical landmarks are with difficulty distinguishable, rather profuse hemorrhage may be encountered. The senior author has been forced to abandon a gastrectomy for cancer, and resort to gastrojejunostomy, on account of furious hemorrhage among pyloric adhesions.

Pneumonia.—Among the German Hospital patients there were no deaths from pneumonia. One patient with phthisis, on whom gastrojejunostomy was done (July 15, 1907) for dilatation of the stomach, developed œdema of the lungs on the eighth day after operation, when convalescence had already set in. We attribute the absence of pneumonia as a postoperative complication largely to the precautions,

already mentioned, which are taken against chilling the patients; but chiefly to the semi-sitting posture assumed as soon as the effects of the anæsthetic pass off.

It is well known that pneumonia is more liable to follow operations in the region of the upper abdomen than those in the pelvis; and this predisposition has been attributed to various causes. The anæsthetic could have no more harmful influence in one case than in the other; indeed, according to Krecke, as long ago as 1901 v. Mikulicz reported a much higher mortality from pneumonia after gastric operations under local anæsthesia than when a general anæsthetic was employed. However, it is certainly well for the anæsthetist to bear in mind that the visceral peritoneum is insensitive (Lennander), and that when once the abdomen has been opened, comparatively light anæsthesia is required until the time comes for closing the incision in the abdominal wall. In spite of its irritating effects on the lungs, we have no hesitation whatever in expressing our preference for ether over chloroform as the anæsthetic in these cases. We always administer it by the so-called "open, drop method."

Kelling holds that post-operative pneumonia in these cases is produced either by inhalation or by direct infection through the diaphragm; and he remarked its much greater frequency in malignant and infectious conditions, than in cases of simple pyloric stenosis or gastric dilatation. Others have taught that the incision in the epigastric region of the abdomen interfered with deep breathing after the operation, the patient restricting his respiratory excursions as far as possible on account of pain, and that in this way the smaller bronchial tubes became clogged with mucus, hypostatic congestion was induced, and the onset of pneumonia favoured. To prevent respiratory difficulty during the operation, we have the patient's arms laid beside him on the table, never pinned up over his chest.

Since surgeons have adopted the habit of sitting their patients up in bed soon after the operation, the prevalence of post-operative pneumonia in gastric cases has markedly diminished; and thus this practice, begun with the erroneous idea that the stomach was emptied by gravity, has been productive of good results, in spite of its mistaken purpose.

As urged by Robson, it is well to direct these patients to inhale deeply three or four times every hour or so, in the hope that thus pneumonia will be prevented, by ridding the terminal bronchioles of accumulated secretion.

It has long been our belief that the injudicious use of saline solution intravenously, as a remedy or supposed preventative of shock, had a tendency to predispose to pulmonary complications, and especially to œdema of the lungs. No one can dispute its value in hemorrhage; but when care is taken to prevent the dissipation of bodily heat it is very exceptional indeed in our experience for patients to be so shocked during any operation, unattended by hemorrhage, as to require the use of saline solution intravenously.

Should pneumonia unfortunately develope, no time should be lost in applying dry cups to the patient's chest, and adopting vigorous medical treatment.

Peritonitis.—Among the German Hospital patients there were eight deaths from peritonitis—two patients in the benign series, and six among the malignant cases. In the patients with benign disease, the primary operation had been a posterior gastro-jejunostomy with long loop (the first operation in 1902, the second in 1905); in both a secondary entero anastomosis was done on account of the developement of the *circulus vitiosus;* and in both leakage occurred after the second operation, in which the Murphy button was employed, and death followed some days later from peritonitis. This form of operation (long loop) has not been employed since September, 1905, and the use of the Murphy button is avoided whenever possible.

Simplification of technique, and more especially the popularization of rubber-covered clamps in abdominal surgery, has nearly eliminated peritonitis as a post-operative cause of death in benign diseases of the stomach. Occasionally, to be sure, a death after operation is encountered from the subsequent perforation of a gastric or duodenal ulcer; but these are very rare cases, as are also the cases in which peptic ulcer of the jejunum developes and perforates before convalescence is established.

Among the malignant cases at the German Hospital, there were four deaths from peritonitis among the palliative operations (2 in

1905, 1 in 1906, and 1 in 1907); and two deaths from this cause among the partial gastrectomies, both in 1905. As the number of operations done has increased year by year, it is to be hoped that peritonitis is being gradually eliminated in these cases also. But it cannot be denied that peritonitis is much more to be feared in malignant than in non-malignant disease, and there probably always will be a small proportion of deaths due to unavoidable peritonitis. In the first of the above cases (Feb. 3, 1905), the operation was a posterior gastro-jejunostomy with long loop, with primary entero-anastomosis by a Murphy button; the patient died on the sixth day, and at autopsy an abscess was found between the loops of small intestine concerned in the entero-anastomosis, thus making the third fatal case to be attributed to the use of the Murphy button. In the second case (Dec. 14, 1905), the modern operation—posterior short loop gastro-jejunostomy—was done, and the patient died on the eleventh day from perforation of a jejunal ulcer on the proximal side of the gastro-enterostomy. In the third case (March 12, 1906) the fatal result is to be attributed to the diseased condition of the gastric wall at the site of the anastomosis. This we think is the element that can never wholly be eliminated as a cause of peritonitis in these cases. In the patients treated by partial gastrectomy it usually will be possible to cut so wide of the diseased area that the sutures will hold securely; but where only a palliative operation is attempted, the surgeon, rather than do nothing, or rather than do a jejunostomy, will often be tempted to make an anastomosis in a portion of the stomach wall already affected, and thus run the risk of peritonitis developing. The fourth and last of the carcinoma patients to die from peritonitis after a palliative operation (April 13, 1907) had a malignant growth involving the pylorus, the gastro-hepatic omentum, the transverse mesocolon, and the pancreas, causing, in addition to the pyloric obstruction, a stenosis of the transverse colon and dilatation of the gall bladder. The operations done were: posterior gastro-jejunostomy, with short loop; cholecysto-colostomy; and entero-colostomy. Death occurred on the fourth day from fibrino-purulent peritonitis.

Two patients died from peritonitis after partial gastrectomy for

carcinoma. In neither could any leakage of the sutured areas be detected after death.

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II. The Vicious Circle after Gastro-jejunostomy.*—By the **Circulus Vitiosus** was formerly understood a train of post-operative symptoms believed to be due to the continued escape of gastric contents by way of the pylorus, and the return of the duodenal contents into the stomach through the afferent loop by way of the gastro-intestinal anastomosis. Fowler suggested the term *reflux* to indicate that condition where the duodenal secretions (afferent loop) or those of the jejunum (efferent loop) passed into the stomach through the gastro-intestinal anastomosis and produced vomiting, but where, for one cause or another, the gastric contents did not obtain access to the afferent loop through the pylorus. Surgeons have thus spoken of the *duodenal* and the *jejunal reflux*, or have designated the latter condition as intestinal regurgitation. In general, however, the expression *vicious circle* has been indiscriminately applied to pernicious or persistent vomiting after gastro-jejunostomy; and as our knowledge of the normal physiology of the stomach has increased, and as our ideas of the mechanism of the operation of gastro-jejunostomy have been very materially altered within the last few years, it is scarcely desirable, even were it possible, to make a distinction in the cause, where we can perceive no difference in the result. Indeed, it is extremely probable that in most cases of gastro-jejunostomy by lateral anastomosis, with open pylorus, precisely the course of events occurs which is stated above to have been the supposed cause of the vicious circle.

A discussion of the supposed *causes* of this condition is, however, of historical interest. No less a surgeon than Terrier has tersely said that it is due to faulty operating—in other words, that it is avoidable by proper technique. Certain it is, that with increased experience the surgeon encounters it less often, and that long series of operations have been reported by various surgeons, without having it once occur. With the modern operation of gastro-jejunostomy it is rarely if ever seen; and although most surgeons have abandoned the anterior operation (save in certain cases of carcinoma) as well as posterior operations with a long afferent loop, because they believe these more

* See John B. Deaver, "The Vicious Circle after Gastro-enterostomy," N. Y. Med. Jour., 1906, i, 26.

apt to be followed by the vicious circle than the short loop or "no loop" method originated by Petersen and popularized among surgeons of Great Britain and America by Moynihan, yet there are still a few surgeons, including Paterson of London, who persist in employing anterior gastro-jejunostomy and who obtain entirely satisfactory results.

Ever since the operation of gastro-jejunostomy was first done, without premeditation, by Wölfler, in 1881, surgeons have been seeking some method by which this vicious circle could be avoided. It is needless here to describe all the technical changes which the operation has undergone in attempting to eliminate this complication. Each individual method has been adopted to overcome what the surgeon believed was the cause of the vomiting. Those who thought it was due to spur formation at the site of the gastro-jejunostomy wound, aimed to prevent this by attaching the jejunum to the stomach for some distance both above and below the opening (Hadra; Lauenstein); those who thought it was due to contraction of the anastomotic opening took measures to insure its patency (Littlewood; Moynihan); those who thought it was produced by pyloric regurgitation, obliterated the pylorus (Mayo); and those who thought that it depended on the discharge of the contents of the afferent loop into the stomach, or on obstruction to the discharge from the afferent into the efferent loop, took measures to overcome this difficulty—some doing an entero-anastomosis between the afferent and efferent loops (Lauenstein; Braun; Jaboulay), and others still further complicating the operation

Fig. 76.—Diagram to show Course of Gastric and Duodenal Contents.

Black arrows indicate normal course, red arrows indicate course after anterior gastrojejunostomy with entero-anastomosis.

by constricting (Wölfler; Chaput; v. Hacker; Fowler) or actually dividing (Doyen) the afferent loop between the entero-anastomosis and the gastro-jejunostomy. But the fact remained that not one surgeon was able to assign a satisfactory cause for the condition, nor always able to avoid it, however great his experience may have been with the operation, or with this much dreaded sequel. The theories of Chlumskij, of Steudel, and of Kelling, have all been disproved in some instances; and although we are forced to the rather humiliating conclusion that we do not know definitely what the actual cause is, we are at any rate convinced that it is best avoided by adopting a simplified instead of a complicated technique, and by giving occasion for the production of as few post-operative adhesions as possible.

The theories suggested to explain the vicious circle may be classed under the following heads:

1. The presence of **bile or pancreatic juice in the stomach.** Although excessive amounts of these may cause nausea, acid eructations, and even annoying vomiting, they cannot alone be held sufficient to account for severe cases of the vicious circle. Dastre's experiments on dogs, and operations of cholecysto-gastrostomy by Terrier and others, show that bile is well tolerated by the stomach; while the success of Moynihan's well-known case, in which, for rupture of the intestine at the duodeno-jejunal juncture, the proximal end of the bowel was closed and the distal united with the stomach (see p. 340), thus forcing all the duodenal contents to traverse the stomach before reaching the jejunum, effectually sets aside the theory that pancreatic juice in the stomach is solely responsible for the symptoms. Indeed, as already remarked, it is extremely probable, if not absolutely certain, in most of the gastro-jejunostomies done by lateral anastomosis at the present day, that the secretions in the afferent loop mix freely in the stomach with the gastric contents, and really are of benefit to the patient (p. 103).

2. The location of the anastomotic orifice at some other than the **"most dependent portion"** of the stomach. This is assuredly not a cause, in itself, since we now know, and might have known eight years ago, if we had heeded the researches of Kelling, that the stomach empties itself only by contraction, not by gravity. Moreover, many

successful operations have been done without regard to the location of the anastomosis at the "most dependent point." Indeed, that point where the anastomosis is made may soon become the "most dependent point" by the drag of the intestine; and yet what is the most dependent point when the patient is erect, will not be so when he is in bed. All of which shows the folly which inspired surgeons who regarded the stomach as a tin can which to be drained must have a hole cut in its bottom, and must then be kept on end if it were to be kept empty.

3. The presence of a **long afferent loop** has been blamed, but, as already mentioned, many entirely successful operations disprove this theory, and we must look elsewhere for a cause.

4. **Obstruction at the gastro-jejunal anastomosis,** of some form or other, is, we believe, the true cause of this condition. The vicious circle was more frequent in the earlier operations because the surgeon damaged the bowels and the stomach more, and produced temporary paresis, or more lasting adhesions; or because the operation was followed by the formation of a spur, a kink, a valve of mucous membrane, or some other form of mechanical obstruction. Kelling very clearly pointed out that if the stomach was damaged (either by the operation or by previous disease, as in far-advanced cancer cases), it could not properly contract after the gastro-jejunostomy; and that under such circumstances the intestines would empty themselves into it. He insisted, moreover, on the gastro-duodenal reflex, by virtue of which the gastric contractions cease so long as the duodenum remains full. If, therefore, there was a patulous pylorus, or if by reverse peristalsis the gastric contents gained access to the duodenum (the afferent loop), the stomach could no longer empty itself by peristalsis until the duodenum was emptied; and if this was prevented by an obstruction at the site of the anastomosis, circumstances were very favourable for the developement of the vicious circle. We will recur again to this topic when discussing the symptoms of the vicious circle.

The employment, then, of a suitable technique will prevent obstruction to the afferent loop at the gastro-jejunal anastomosis, and

will prove the correctness of Terrier's contention that the vicious circle is due to faulty operating.

The **symptoms** of the vicious circle usually do not develope for several days after the operation. At first there may be merely a slight regurgitation of bile-stained fluid; later, when more food is taken, fæcal matter may be vomited, the regurgitation then taking place from the efferent loop.

Several cases have come under our observation in which convalescence after the gastro-jejunostomy was satisfactory, but occasionally there would be copious vomiting of biliary matter. Meals were eaten with appetite, no discomfort ensued, but three or four hours after the meal this copious biliary vomiting would occur. The patients did not lose in weight. One patient gained forty pounds during the first year after the gastro-jejunostomy, but the vomiting of pancreatic and bilious fluids was so persistent and annoying that she finally submitted to another operation. The fact that these patients vomit practically no food, that digestion is accomplished without special discomfort before vomiting occurs, and that they do not lose in weight, are all important factors to be considered. We are assured from these facts that in such cases digestion and assimilation are accomplished fairly well; but that the excess of bile and pancreatic juices in the stomach finally causes vomiting. As has already been pointed out, the stomach tolerates well a moderate amount of bile and pancreatic juice and their presence in the stomach interferes in no way with the digestion or health of the individual. In searching for the explanation of the mechanism present in the class of cases just described, it seemed to us that the course of events might well be the following: The form of operation primarily employed was posterior gastro-jejunostomy with a long afferent loop. It was probably the length of the loop that saved the patient's life. There was formed an obstruction to the intestinal canal at the site of the gastro-jejunostomy. The duodenum and afferent loop became filled with food and bile and pancreatic juice. Some food no doubt passed into the efferent loop, but the important point for us just now is that the proximal (afferent) loop became filled, either by anti-peristalsis through the gastro-jejunostomy opening, or through the pylorus. When this proximal loop became

filled, stomach action ceased, according to the gastro-duodenal reflex of Kelling, to which allusion has already been made; hence there was no vomiting soon after eating; and as the proximal loop was long, it held a fair quantity of food; this food was digested in, and was largely absorbed from the proximal loop; though no doubt some food was discharged from the stomach directly into the distal (efferent) loop, and was digested in and absorbed from it. The longer the proximal loop, the more would it hold, and the better would digestion in it be accomplished. When the proximal loop was finally emptied by absorption, stomach movements returned, and the surplus of biliary and pancreatic secretions which had entered it from the duodenum, as well as the residue of food, if any remained, were rejected by vomiting.

There were sometimes seen instances of the vicious circle which more imperatively demanded relief than those patients just mentioned. In such cases the vomiting was persistent from the time of the operation, emaciation was rapid, and unless something had been done speedily to relieve the patients, they would have died of exhaustion and inanition; in fact, all the symptoms of a high intestinal obstruction were present.

The **treatment** should at first be palliative. The patient should be sat up in bed, the stomach washed out, and all food by the mouth stopped. Nutritive enemata should be employed if mouth feeding cannot be resumed promptly. When vomiting has been absent for twenty-four or thirty-six hours, a very little liquid food may be given by mouth—a drachm every hour or two; but this must again be stopped if the vomiting reappears. In the less severe cases it is sometimes sufficient to employ lavage every second or third day; light diet, in small quantities, being taken meantime. We have known a patient content to live in this way for some months.

If a cure is not spontaneously effected thus, or immediately if the symptoms are urgent, the abdomen should be reopened, and mechanical correction of the obstruction attempted. Operation should not be postponed so long that the patient's strength will not be sufficient to stand the shock; and, on the other hand, too extensive an operation should not be employed on such debilitated patients.

The following case, which has been published elsewhere in detail

by Dr. Deaver, is quoted here as illustrating many points of importance in this connection.

A young woman of 24 years, who for three years had presented symptoms of gradually increasing pyloric obstruction, was operated on at the German Hospital, by Dr. John B. Deaver, July 8, 1903. Numerous adhesions were found about the neck of the gall-bladder and duodenum. The gall-bladder was normal, but slightly distended; the stomach was slightly enlarged, somewhat proptosed, and the pylorus was thickened. A posterior trans-mesocolic gastro-jejunostomy was done, with sutures, the afferent loop being about ten inches long.

The patient did well and was free from vomiting for five days. On July 13th, 700 cc. of dark green bile were vomited; her general condition was good.

July 15th. Patient vomited bile during the night. Appetite good, feels better than she has in years. Stitches removed. Wound healed.

July 17th. Patient vomited bile with small portion of fæcal matter.

July 18th. During early morning the patient vomited; vomitus stercoraceous in character, about 300 cc.; and an intestinal obstruction was believed to have taken place, necessitating a second operation.

Second operation, July 18, 1903 (ten days after the first operation). Omentum found adherent to abdominal scar; adhesions separated, and omentum and transverse colon were turned upward. This reflection upward carried several coils of small bowel along, and it was found that the proximal and distal limbs of the anastomosed loop were firmly adherent to the posterior layer of the transverse mesocolon, interfering to a marked degree with the peristalsis of the bowel. The adhesions were all separated, and the denuded surfaces were inverted with silk sutures, or covered with Cargile membrane. The gastro-jejunostomy was apparently perfect. An entero-enterostomy was then performed, by sutures, 15 cm. (six inches) from the gastric anastomosis.

There was some vomiting of green material upon the two days following operation, but this stopped upon the use of lavage.

July 25th. Stitches removed, wound healed.

July 26th. Patient vomited twice about 300 cc. of light greenish material. Wine of ipecac, 10 drops every hour, was given.

July 27th. No vomiting.

July 31st. Ipecac stopped.

Aug. 2nd. Vomited 300 cc. of light green material about 10 p. m. Vomiting could not be attributed to anything eaten. Given 10 drops of wine of ipecac every two hours during day.

Aug. 7th. Vomited small quantity of yellow material. Ipecac stopped.

Aug. 12th. Discharged. Condition fine; is gaining weight, and has not vomited since Aug. 7th.

On Sept. 14, 1903, this patient was readmitted to the German Hospital. She stated that on Aug. 16th, four days after her discharge, vomiting had recommenced, at first of bile, and later of food and bile. When admitted she vomited everything given by mouth, and large quantities of thick, ropy, dark green material, with a very strong odour. Feeding by rectum was begun, but the patient continued to vomit the

thick, dark green material, containing large quantities of bile. On washing out the stomach large quantities of the same material were obtained. She was well nourished, notwithstanding the vomiting, proving that the food must have been digested in great part, especially as the patient did not seem to have lost much weight. Examination of the eyes was negative; the pelvic organs were normal; and no constitutional cause for the vomiting could be found.

Third Operation, Sept. 19, 1903. The omentum was found universally adherent, and there were dense adhesions between the coils of bowel. The gastro-jejunostomy was exposed, and the opening found to be freely patent. The entero-enterostomy was exposed, some difficulty being encountered in distinguishing the anastomosis by reason of the numerous adhesions. When these were separated the anastomosis was found to be in perfect condition, with some sacculation. Adhesions were further separated throughout the abdominal cavity. The entire omentum was ligated and cut away. The gall-bladder was found normal in size, numerous adhesions surrounding it; the stomach was normal in size. By means of a pedicle needle a piece of silver wire was passed around the pylorus and tied. The abdominal cavity was filled with normal salt solution, and the abdominal wound closed by tier suture. The patient was shocked, the pulse being barely perceptible at the close of the operation. An intravenous injection of saline solution was given before she left the operating room.

Sept. 20. Patient vomited bile several times during the day.

Sept. 22. Buttermilk ordered. Patient feels somewhat distressed in the epigastric region, no vomiting.

Sept. 23. Patient feels well; no epigastric distress.

Sept. 29. Eating light diet. No nausea or distress.

Oct. 10. Patient vomited after breakfast.

Oct. 11–15. Patient vomited several times each day; complained of some abdominal pain; there was some tympanites. For symptoms of obstruction, it was determined the next day to re-open the abdomen.

Fourth Operation, Oct. 16, 1903. A coil of small intestine was found closely adherent to the parietal peritoneum. The intestines were found universally adherent to each other, and to the remains of the omentum, binding together the transverse, ascending and descending colon and sigmoid flexure, and various loops of small intestine, one to another. No portion of the bowel, excepting about five feet of the ileum, was free from adhesions. The adhesions were separated, bleeding points ligated, and all denuded surfaces covered with Cargile membrane. The entero-enterostomy and the gastro-jejunostomy were examined and found patulous. At no portion were the intestines collapsed or unduly distended. The abdomen was closed by through-and-through sutures of silkworm gut.

Oct. 17. Much vomiting.

Oct. 19. No vomiting.

Oct. 29. Sutures removed; wound healed.

Nov. 2. Patient allowed to sit up in a chair. No vomiting; feels strong.

Nov. 9. Patient walking about.

Nov. 13. Patient went home.

The patient was at home for ten days when she again began to vomit as before: in the morning bile; later in the day particles of food; would vomit two or three

times every day. On re-admission her nutrition was good. On the abdomen were two scars of former operations. Slight distension of the stomach.

Fifth Operation, Dec. 7, 1903. An incision seven inches long was made, dissecting out the last cicatrix. On opening the peritoneum many adhesions were found between intestines and under surface of incision. Universal adhesions were present throughout the intestinal canal; these were carefully dissected free, and two holes in the intestine, which were accidentally made, were closed with sutures of silk. Abdomen was filled with salt solution, and wound closed with through-and-through sutures of silkworm gut.

Jan. 14, 1904. Patient apparently entirely well. She remained in good health for one year, and then died of unknown cause, but with no gastric symptoms.

This unfortunate woman, therefore, had undergone five operations, one after the other, for the relief of severe vomiting. An entero-anastomosis and an occlusion of the pylorus both had failed to relieve her condition. Every cause for vicious circle or for jejunal reflux seemed to have been eliminated, except the influence of adhesions, which were encountered at each operation. The patient gained in weight even while vomiting, indicating that the digestive power was not seriously impaired.

The senior author's experience with the vicious circle embraces ten cases, which may be thus classified:

1. Among 25 operations of posterior gastro-jejunostomy, with long afferent loop, and without primary entero-anastomosis.	Eight patients developed the vicious circle; 5 of these recovered, and 3 died, after secondary operations.
2. Among 19 operations of posterior gastro-jejunostomy with long afferent loop, and with primary entero-anastomosis.	One patient, who was cured by secondary operation.
3. Among 72 operations of posterior gastro-jejunostomy with short loop.	One patient, who was cured by secondary operation.

Probably no more forcible comment is needed on the disadvantages of the long loop posterior gastro-jejunostomy.

The eight patients in the category where no primary entero-anastomosis was done, who developed the vicious circle, were re-operated on at intervals varying from four days to one year after the primary operation. In six cases an entero-anastomosis was done at the secondary operation; four of these six patients were thus relieved of their symptoms, but the remaining two patients died after the secondary operation from peritonitis due to leakage of the Murphy

button employed in making the anastomosis. The seventh patient was treated (April, 1904) by resection with end-to-end anastomosis by suture of the distended afferent loop, thus converting the operation into one of the modern short loop gastro-jejunostomies; but this patient died two days after this secondary operation, of exhaustion. The last of these eight patients was operated on for the vicious circle one year after gastro-jejunostomy by this method (posterior long loop, without entero-anastomosis) had been done in another hospital by another surgeon. In this patient relief was obtained by the performance of an entero-anastomosis, ligation of the pylorus, and ligation of the afferent loop (Fowler). She was last heard from more than two years after this secondary operation, and was in good health, and feeling much better than before this last operation, though still somewhat troubled by gastric symptoms.

The only patient who developed the vicious circle among the series of long loop gastro-jejunostomies in which a primary entero-anastomosis was done, was entirely relieved of his symptoms by a secondary ligation of the pylorus, employed three months after the primary operation. He was last heard from two and a half years after the secondary operation, was in excellent health, and had no symptoms referable to the stomach.

In the third series of cases (posterior gastro-jejunostomy with a short loop), there was one patient, operated on in December, 1905, who developed regurgitant vomiting. Five months later it was found at the secondary operation that the gastro-jejunostomy opening was patent; that the pylorus was obstructed, but that the short proximal loop did not appear to be draining well. Finney's pyloroplasty was therefore done, as well as an entero-anastomosis between the short afferent loop and the efferent loop of the jejunum. Recovery was uneventful; but although the regurgitant vomiting was relieved, the patient when last heard from, over two years later, could only be classed among those "much improved" by operation. In looking back at this case it seems not impossible that it was one of those in which, as pointed out by Mayo, the jejunum has attached to it for some distance from its origin, a peritoneal fold running from the transverse mesocolon, and that owing to failure to recognize this

anomaly, the operation instead of being a short loop gastro-jejunostomy became in reality a long loop operation. One similar case has been encountered since, but in this the peritoneal fold was recognized, divided, as recommended by Mayo, and the usual operation done, with the usual satisfactory result.

In common with all surgeons who did stomach surgery as long as twelve or more years ago, the senior author's earliest gastro-jejunostomies (for carcinoma) were done on the anterior wall of the stomach, by means of the Murphy button. It was not long, however, until the posterior operation was adopted, still employing the Murphy button. In the anterior operation a long afferent loop of jejunum is obligatory, on account of the necessity of spanning the transverse colon and great omentum; and, again in company with other surgeons, the senior author pursued the same technique in performing the posterior operation, not appreciating at that time the drawbacks and the positive dangers of the long afferent loop. Believing that the regurgitant vomiting observed in some of these cases was due to obstruction at the anastomotic opening, preventing the proximal (afferent) loop of jejunum from freely emptying itself into the distal (efferent) loop, the technique was then changed so as to include at every primary operation an entero-anastomosis between the afferent and efferent loops, thus making sure that obstruction to the afferent loop could not exist. This method proved for a long time satisfactory, although its performance consumed more time than the simple gastro-jejunostomy alone. To make this additional time as short as possible, a Murphy button was at first employed in making the entero-anastomosis, but when disaster directly traceable to the use of the Murphy button occurred, this method was abandoned, and since that time simple sutures have been employed.

Even while employing the method of posterior gastro-jejunostomy with the long loop and entero-anastomosis, we were, of course, quite well aware of the brilliant results of other surgeons from the "short loop" and the "no-loop" operations; but as long as the technique being employed proved satisfactory, it seemed poor surgery to change that technique merely to keep in fashion. In the course of time, however, it came to pass that a patient on whom this operation had

been done, returned with the vicious circle. This patient, as already described, was entirely relieved of his symptoms by ligation of the pylorus. Since that time the short loop operation has been employed, and the vicious circle is now never a sequel of the operation.

We would recommend, therefore, the following course in the operative treatment of the vicious circle, following posterior gastro-jejunostomy with long afferent loop:

1. Entero-enterostomy between the afferent and efferent limbs of the jejunal loop. If this failed to relieve,
2. Ligation of the pylorus should be the next step, while
3. Occlusion of the afferent loop between the entero-anastomosis and the gastro-jejunostomy may be done as a final step.

Should for any reason the performance of entero-enterostomy be peculiarly difficult, probably the next best step would be to divide the afferent loop close to the gastro-jejunostomy, suture its distal end, and implant the proximal coil (afferent loop) into the jejunum at least eight inches below the gastro-jejunostomy. This would supplant the lateral anastomosis by a posterior gastro-jejunostomy in-Y, according to the method of Roux.

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III. Peptic Ulcer of the Jejunum after Gastro-jejunostomy.—This is a rare sequel. Among the thousands of gastro-jejunostomies which have been reported by surgeons the world over, Key (1907) was able to find only 55 instances recorded in which a peptic ulcer had been certainly observed. Moynihan (1908) has collected 60 cases. It is perhaps true that in some patients the symptoms of gastric trouble which recur after apparent cure following gastro-jejunostomy may be due not to recurrence of the gastric trouble, but to an unsuspected peptic ulcer of the jejunum; but until discovered at operation or at autopsy this must remain a pure supposition, since we have at present no means of accurately distinguishing during life the symptoms of jejunal from duodenal or gastric ulcer.

According to Gosset, whose excellent monograph has been freely drawn upon in preparing the following account, it was not until 1899 (seventeen years after the operation of gastro-jejunostomy was first performed) that Braun reported the first case of peptic jejunal ulcer, which in his patient developed one year after gastro-jejunostomy. The first French case was reported by Quénu in 1902, and the first in England by Mayo Robson in 1904. This shows that it is not a complication of very frequent occurrence, since even before 1904 the number of gastro-jejunostomies which had been performed was very considerable; and since the case observed by Gosset himself, in 1905, was only the second to be reported in France.

The relative frequency of this sequel may be seen by the following figures: these have been purposely drawn from rather ancient statistics, both because modern operations are seldom followed by this complication, and because we prefer to exaggerate rather than to underestimate the occurrence of so fatal a catastrophe.

Operator.	No. of Gastro-jejunostomies.	No. of Peptic Jejunal Ulcers.
Hartmann (Bull. Soc. Chir. Paris, 1904, xxx, 198)	131	0
Kausch (cited by Connell: Surg., Gyn. and Obst., 1908, i, 39)	160	2
Krönlein (Schostak: Beitr. z. klin. Chir., 1907, lvi, 360)	92	1
Mikulicz (cited by Robson: Annals of Surg., 1904, ii, 186)	136	2
Moynihan (cited by Connell: Surg., Gyn. and Obst., 1908, i, 39)	218	1
Paterson, collected cases (Lancet, 1906, i, 491; 574)	295	3
Robson (Annals of Surg., 1904, ii, 186)	166	1
Total	1198	10

It occurs, therefore, in less than one per cent. of gastro-jejunostomies, without regard to the special technique adopted. But from Key's figures it is very clear that the method of operation has a great deal to do with the relative frequency with which peptic jejunal ulcer developes. Thus he found that

After	anterior gastro-jejunostomy	there were	33	cases.
"	posterior gastro-jejunostomy	" "	13	"
"	" "	in-Y, " "	4	"
"	" "	with entero-anastomosis	5	"

If, now, we recollect that in the statistics from which his figures were drawn, the Y operation was probably employed less frequently than any of the others; that the operations of anterior gastro-jejunostomy probably did not largely predominate in number over the posterior; that in the large majority of the posterior operations a long afferent loop existed; and that the posterior gastro-jejunostomies with primary entero-anastomosis probably very nearly equalled in number those done without this entero-anastomosis; it then becomes very evident that the supposed immunity of the Y-operation is more apparent than real, and that the anterior operation is more likely than any other to give rise to the developement of a peptic jejunal ulcer.

The **site** of the peptic ulcer of the jejunum was noted in 34 cases studied by Schostak. In 18 patients the ulcer was in the jejunum below the site of the gastro-jejunostomy; in 15 patients it was on the margin of the gastro intestinal anastomosis; and in 1 patient it was on the margin of the entero-anastomosis.

The **cause** of this fatal complication has always been assumed to be the action of the hyperacid gastric secretions on a portion of the intestinal canal unprotected by the alkaline secretions of the duodenum; and the greater frequency of peptic jejunal ulcer after anterior gastro-jejunostomy and after posterior long loop operations in which no entero-anastomosis was done, certainly seems to support this theory. Moreover, this complication has been noted, according to Connell, only once (Lennander), after gastro-jejunostomy for cancer, in which disease gastric acidity is absent or much diminished. But we think surgeons, and perhaps pathologists also, do not sufficiently realize that peptic ulcer, whether in the stomach, the duodenum, or the jeju-

num, is possibly as much a symptom of disease as a disease itself; in the same way that the ulcerated Peyerian patches of typhoid fever do not themselves constitute the whole of the disease. Thus it is not beyond the bounds of possibility for future experience to show that peptic ulcers of the jejunum may exist in immature state (hemorrhagic ecchymosis, exulceratio simplex, etc. See p. 71) in some patients with gastric ulcer, even at the time of operation; and that therefore their subsequent developement into perforating or hemorrhagic ulcers may occur in spite of, but by no means as a consequence of, the gastro-jejunostomy.* At present, however, this reasoning is purely theoretical; and the only clinical cause to which we can safely refer is the apparent influence of anterior gastro-jejunostomy in producing this sequel.

Among Gosset's cases, 29 were in men, only 2 in women.

Symptoms may arise within a few days, or not for many years. The shortest interval noted was ten days; and in one case referred to by Gosset, the interval was seven years. In a case subsequently reported by Edington there was also an interval of seven years. The majority of cases of perforation (which is usually the first manifestation of the ulcer) occur between one and two years after the operation. Gosset found 17 cases within two years, and 10 cases after this period of time.

The perforation was subacute in 20 cases; acute in 8; while in 3 cases perforation into a hollow viscus occurred (Gosset).

Prophylaxis is of more value than are remedial measures. The simpler the technique of the primary operation, the more likely will it be to cure the gastric condition, and therefore to restore the patient's gastro-intestinal tract to its normal condition. Thus while Robson observed one case of peptic jejunal ulcer among 30 anterior gastro-jejunostomies, he did not have it occur at all among 300 modern posterior operations. But in addition to the employment of a proper operation, it is above all things important for the surgeon to impress on the patient the fact that operation is only one step in the cure of gastric ulcer—that, as pointed out at p. 160, operation is often only a mechanical device to allow medical, dietetic, and other chemical meas-

* Blanc and Mossé have quite recently narrated the history of a patient with symptoms resembling pyloric obstruction, which were found at operation to be due to stenosis of the upper jejunum from ulceration.

ures to become effective. If this fact were constantly borne in mind, indiscretions and negligences in diet and in oral hygiene (to the latter of which Robson attributes a very important rôle) would be less apt to occur, and the possibility of jejunal ulcer developing would be correspondingly diminished.

The **treatment** is the same as for perforation elsewhere in the intestinal tract. The **prognosis,** however, is not so good as in cases of gastric or duodenal perforation. The history of the previous operation, and the more or less subacute character of the symptoms in many cases, may make the surgeon hesitate to intervene promptly; and the reserve strength of these patients is apt to be slight.

If simple suture of the perforation seem, as it usually will, inexpedient, probably the best method of operation will be that successfully adopted in his case by Robson, viz., excision of the affected coil of jejunum, and performance of Roux's operation.

Edington collected nine operations, including one by himself, for *acute* perforation of a peptic jejunal ulcer; only two patients recovered. Gosset collected 23 operations for peptic ulcer of the jejunum following gastro-jejunostomy; 19 of these patients recovered, some of them only after several operations had been performed. Among these 23 operations noted in Gosset's monograph, there were 3 *acute* perforations, with one death, the cause of the peritonitis being found only at autopsy; there were 4 *subacute* perforations (perigastric abscesses), which all recovered; and 13 *chronic* perforations, with 2 deaths. There were, further, three instances in which perforation occurred into another portion of the intestinal tract—two gastro-colic fistulæ, implicating also the jejunum, and one case of jejuno-colic fistula without involvement of the stomach.

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IV. Internal Hernia after Gastro-jejunostomy.—This complication is rarely observed. When a long afferent loop was habitually used in gastro-jejunostomy there was always a possibility that some coils of small intestine might slip between this loop and the anastomosis, and thus become strangulated. While more likely to occur after the anterior operation, as in Mayo's case, it may also follow posterior gastro-jejunostomy with a long loop. Even without an actual hernia, the long loop has been responsible for death in a small number of cases by producing obstruction through volvulus of the anastomosed loop, or by drawing the mesentery so taut as to strangulate the lower bowel beneath it.

Another sequel, which has followed trans-mesocolic operations, is the occurrence of a hernia through the opening in the transverse mesocolon into the lesser peritoneal cavity. Hartmann, Moynihan, and Harte have each had such a case; but since the possibility of such an event has been recognized its occurrence has been prevented by the nearly universal custom of suturing the edges of the mesocolic opening around the gastro-intestinal anastomosis.

Two such cases have come under the notice of Dr. Ashhurst: In the first patient (at the Episcopal Hospital, in 1902), death occurred from strangulation of the small intestine between the mesentery of the afferent loop and the posterior abdominal wall. In the second patient (at the Pennsylvania Hospital) a hernia of the small bowels into the lesser peritoneal cavity took place through an unsutured opening in the transverse mesocolon; though the hernia was reduced at a second operation, the patient eventually died.

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Moynihan: Abdominal Operations, Phila., 1905, p. 169.

V. Gastric Fistulæ.—These are classified by systematic writers as the Internal and the External varieties.

External Gastric Fistula (Gastro-cutaneous Fistula).—Lieblein and Hilgenreiner (loc. cit., S. 420) in 1905 found more than 120 cases of this unusual affection recorded. The subject has been more recently studied by Patel and Leriche. This sequel may follow either lesions of the stomach itself, or affections of neighbouring organs. Among the **causes** are:

1. *Traumatisms.*—Stab or gunshot wounds (as in Beaumont's patient, Alexis St. Martin) were more apt to be followed by the development of a gastro-cutaneous fistula in former times when patients were left either to die of themselves, or to recover in such condition as might be determined by the natural course of events. At present, when practically all such cases are subjected to immediate operation, this sequel is very rare. The stomach may also be perforated from within by foreign bodies which have been swallowed. Lieblein and Hilgenreiner refer to two such cases.

2. *Gastric ulcer* is one of the recognized causes of this condition. It may result from perforation when the stomach is adherent to the abdominal parietes, or secondarily, through the external rupture of a perigastric abscess.

3. *Carcinoma of the stomach* was noted as the cause in 26 cases among those collected by Lieblein and Hilgenreiner. As with ulcer, cancer may directly implicate the abdominal wall, or a perigastric abscess may form first. It is also possible for secondary growths in the skin, especially at the umbilicus, to perforate the stomach.

4. *Strangulated hernia* is a very much less frequent cause of gastric than it is of intestinal (fæcal) fistula.

Among diseases of neighbouring structures, which may cause fistulous tracts to form between the stomach and the integument, must be mentioned, besides inflammatory and malignant diseases of the abdominal wall, affections such as hepatic and subphrenic abscesses; caries of the ribs or sternum; hydatid cysts; cysts of the pancreas, etc.

Prophylaxis is better than cure. In very many cases the only **treatment** that can be attempted will be palliative; moreover, these fistulæ not infrequently heal of themselves. If due to benign disease

(perigastric abscess, injury, etc.), an operation may properly be undertaken. Billroth, in 1877, was the first to perform gastrorrhaphy for this condition. By opening the peritoneal cavity to one side of the fistula, and carefully excluding all surrounding organs by gauze packs, it frequently will be possible to dissect the fistulous tract free, and suture the gastric opening. In other cases it may be better to attempt the closure of the fistula by freshening its edges, and transplanting a flap of skin to cover the defect. In patients who cannot be properly nourished on account of persistent leakage, jejunostomy may be done.

Internal Gastric Fistula.—As the result of disease or injury a fistula may form between the stomach and almost any neighbouring organ, or even with another part of the stomach itself. The colon is most often involved (gastro-colic fistula); but communications have been recorded with the duodenum, œsophagus, small intestine, gall bladder; and fistulous tracts leading to structures within the thorax (lung, heart) have been observed occasionally. The majority of these rare sequels of gastric disease are of pathological interest only. A few, however, may be benefitted by surgical treatment. Their pathogenesis is much the same as in the case of the external fistulæ.

Gastro-colic Fistula.—Lieblein and Hilgenreiner (loc. cit., S. 437) collected 95 cases of this form of internal gastric fistula. The *cause* was recorded in 65 of the 84 cases studied by Chavannaz: 47 were due to carcinoma (38 to gastric, 6 to colic cancer, the site in 3 cases not being recorded); 11 were due to ulcer (7 certainly, 4 only probably); 5 were the result of tuberculous disease of the stomach or colon; and 2 followed the formation of perigastric abscess.

The *symptoms* are fæcal vomiting and lienteric diarrhœa. The ingested food, especially such articles as vermicelli, quickly appear in the stools and the similarity of the vomitus and the dejections is an important sign.

The *diagnosis* may be confirmed by distending the colon or the stomach with air, and finding that the organ in communication becomes distended at the same time; or injection of colored fluids may be tried. Such tests are more apt to be successful when made through the bowel.

The *prognosis*, without operation, is gloomy. Chavannaz refers

to two cases in which the fistula is said to have closed spontaneously, but neither patient was traced long afterward.

Palliative treatment consists in administering opiates or purgatives accordingly as there is diarrhœa or constipation.

Surgical treatment appears to have been undertaken in seventeen patients. Six of the operations consisted, according to Chavannaz, in opening a perigastric abscess (2 patients), exploratory laparotomy (3 patients), or gastrotomy (1 patient). The operations of greater interest may be thus classified:

1. Colotomy. This operation is only palliative, and may be undertaken as a last resort to check fæcal vomiting, by providing a false anus above the fistula between the stomach and colon. The emaciation due to escape of food directly from the stomach into the colon would not be prevented. This operation was employed in one patient (Edmunds, 1884); no improvement resulted and death occurred 15 days later, the patient also having cancer of the rectum.

2. Jejunostomy. This operation is also merely palliative, but in cases of extreme emaciation would be of slightly more value than colotomy. It has been employed once (Labhardt and Eiselsberg, 1901); the patient probably had cancer, but improved, and returned to his home one month later.

3. Separation of stomach from colon, with suture of orifices. This undertaking is the most radical of all, and may lead into rather extensive resections of the diseased stomach or colon. It has been employed in four cases, as follows: (1) Henschel and Reichel, 1894: partial resection of gastric wall, and resection of portion of transverse colon, including entire lumen, for cancer. Operation lasted three hours and a half and ended fatally. (2) Fischer, 1888: resection of abdominal wall, of anterior wall of stomach, and of transverse colon; implantation of duodenum into remains of stomach, and fixation of both ends of colon in abdominal wound, for carcinoma. In spite of a secondary growth in the liver, noted at the time of operation, the patient recovered from the operation, lived five months, and died of carcinoma of the liver. (3) Czerny, 1902: separation of gastro-jejunocolic fistula, occurring two months after posterior gastro-jejunostomy, with suture of the openings of the stomach and colon, and the per-

formance of a new gastro-jejunostomy. Recovery. (4) Kauffmann, 1905, separation of the structures concerned in a gastro-jejuno-colic fistula (occurring four years after posterior gastro-entero-anastomosis), with ileo-sigmoidostomy for stricture of transverse colon caused by suture of the two perforations in the colon. Time of operation, three hours. Six days later the abdomen was again opened for symptoms of perforation. These were found to be due to perforation of the sigmoid by the button used in making the anastomosis. The patient died on the table at the second operation.

4. Exclusion of the gastro-colic fistula. This may be either a complete exclusion, or a simple short-circuiting operation. (*a*) Complete Exclusion. Three such operations are referred to by Chavannaz. (1) Zweig and Hahn, in 1900, made an anastomosis between the transverse colon (above the fistula) and the sigmoid, and then occluded the colon on each side of the fistula by a pursestring suture. Time of operation, two hours and a half. Patient recovered and was in good health three years later. (2) Unruh and Garré, in 1899, divided the transverse colon above and below the fistula, closed all four ends of the colon, and then united the transverse colon above the fistula to the descending colon. The portion of the colon involved in the fistula was thus converted into a diverticulum of the stomach. The operation lasted two hours; the patient recovered, and was in good health 9 months later. (3) Kelling, in 1903, divided the transverse colon on both sides of the fistula, closed the ends of the gastric segment of colon by purse-string sutures, and did end-to-end anastomosis of the transverse colon. His patient recovered, but died 19 months later from cancer of the stomach.

(*b*) Short-circuiting has been adopted in two cases mentioned by Chavannaz. Labhardt and Garré, in 1901, did a colo-colostomy of the transverse colon above and below the fistula. Their patient improved, and the fæcal vomiting stopped. Chavannaz, in 1906, united the ascending colon to the sigmoid, for fæcal vomiting due to cancerous fistula. The vomiting was not improved and the patient died in fifteen days.

It is interesting to note in this connection that Mauclaire pur-

posely produced a gastro-colic fistula with the hope of relieving severe gastralgia which recurred one year after the performance of a posterior gastro-jejunostomy. On reopening the patient's abdomen, he found the gastro-jejunal anastomosis in good condition, and determined to do a gastro-colic anastomosis because, in a previous similar case, no benefit had been derived from a second (anterior) gastro-jejunostomy. In his second patient the pylorus was thickened and indurated, but there was no open ulcer. The patient was much improved (!) by the formation of the gastro-colic fistula, but was not cured. Surely pylorectomy would have been better.

Jejuno-colic Fistula.—Gosset has recorded a successful operation for this complication, caused by the perforation of a peptic jejunal ulcer two years after posterior gastro-jejunostomy. He separated the jejunum and colon, sutured the perforations, and did ileo-sigmoidostomy because of the stricture thus produced in the colon.

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VI. Duodenal Fistula.—This extremely fatal complication of upper abdominal lesions may follow either disease or trauma. Among the latter must be included operative injuries, such as are sometimes sustained in operations on the bile passages (Kraske, Kehr, Lilienthal, Mayo, Fink, Berg), or on the right kidney (Schede, Cackovic). Lieblein and Hilgenreiner refer to sixteen cases of duodenal fistula, eight of which were collected in 1903 by Cackovic.

The *causes* are various. Perforation of an ulcer usually has produced a fistula above the bile papilla, while operative fistulæ are more often below this level, as are also fistulæ the result of rupture or gunshot wounds of the duodenum (see p. 340). The cutaneous orifice of the fistula is frequently in the right hypochondrium, but if the fistulous tract is retro-peritoneal, its outer opening may be in one of the intercostal spaces (Steaten, Gross), in the loin (Hinton), or even in the right inguinal region (Wagner); in Rintel's case the fistula was due to tuberculous peritonitis, and was at the umbilicus.

The *diagnosis* can be made usually with comparative ease, differentiation from gastric fistula, the only lesion with which it is readily confused, presenting few difficulties.

The *prognosis*, unless the fistula is a sequel of operation, is bad. Duodenal fistulæ following operation, whether from pressure of a drainage tube, from necrosis due to partial obliteration of the blood supply, or to an injury undiscovered during the operation, usually heal spontaneously. But if the fistula is the result of duodenal ulceration, with subphrenic abscess or a long retro-peritoneal suppurating tract, emaciation is rapid, and if the patient does not die of starvation, he is liable to do so from sepsis. Except for several post-operative cases, we know of no instance of recovery from duodenal fistula.

The only *treatment* which offers any hope of cure is operation. Traumatic lesions alone are suitable for suture (duodenorrhaphy). When the fistula follows ulceration, much more may be hoped for from gastro-jejunostomy combined with unilateral exclusion of the duodenum by ligation of the pylorus. This operation was suggested by Cackovic and by Berg in 1903. Berg's first patient lived seventeen days; but in his second case he attempted to suture the perforation at the same time that he did gastro-jejunostomy; the sutures gave way,

and then occlusion of the pylorus was performed too late to save the patient. In patients with extreme emaciation jejunostomy may be performed with the hope of doing a more radical operation should sufficient strength be gained. Cackovic tried this plan, but his patient died in two days.

Internal Duodenal Fistula, *i. e.*, gastro-duodenal, duodeno-colic, cholecysto-duodenal, etc., is so rare as to be of pathological interest only.

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VII. Subphrenic Abscess.—This serious complication, though due to a variety of causes, is in such a large proportion of cases due to precedent gastric or duodenal disease, as to render it worthy of rather extended notice in this volume.

By the term subphrenic abscess is strictly understood only those abscesses formed between the dome of the diaphragm and some subjacent organ; but as usually employed the expression is made to embrace practically every abscess which at one portion or other of its circumference comes into contact with some portion of the diaphragm. Thus an abscess between the left lobe of the liver and the anterior gastric wall is included among subphrenic abscesses because of its close relation to the attachments of the diaphragm in the left epigastric and hypochondriac regions; and one in the lesser peritoneal cavity will also be included because, by extending outward toward the spleen, or upward and backward along the Spigelian lobe of the liver, it will come into contact with the diaphragm in those situations.

The first description of subphrenic abscess, according to Freeman, was that of Barlow, in 1845. In 1862 it was accurately described by Bouchard; and the first operation was recorded by Volkmann, in 1879. Maydl, in 1894, published a monograph on the subject based on a study of 179 cases. Finkelstein in 1899 collected 252 cases; and the subject has recently been discussed by Barnard, to whose excellent papers we are glad to acknowledge our indebtedness in preparing the present account.

A study of the pathogenesis of subphrenic abscess is considerably simplified by dividing the area beneath the diaphragm into certain definite anatomical regions, as done by Barnard: "The under surface of the diaphragm is marked out into four peritoneal spaces and two cellular ones. The four peritoneal spaces are separated from one another by the cruciform arrangement of the ligaments of the liver—namely, the coronary, falciform, and the right and left lateral ligaments. The falciform ligament divides the subphrenic space into two parts, right and left. Each of these is again subdivided into a larger anterior and a smaller posterior part by the corresponding lateral ligament." The two cellular (extra-peritoneal) subphrenic areas are (1) that included between the layers of the coronary liga-

ment; and (2) that extending from the cellular tissues around the upper pole of the left kidney up to beneath the left dome of the diaphragm. Barnard therefore classifies the subphrenic fossæ thus:

A. Intra-peritoneal. { I. Right. { 1. Anterior. 2. Posterior. } II. Left. { 3. Anterior. 4. Posterior. }
B. Extra-peritoneal ..... { 5. Right. 6. Left. }

1. An abscess in the right anterior intra-peritoneal region is bounded above by the diaphragm, below by the right lobe of the liver, on the left by the falciform ligament; in front usually by adhesions between the hepatic margin and the anterior abdominal wall; while on the right such an abscess is frequently continuous with the right kidney pouch, from which direction the infection has most often travelled. Of 27 abscesses in this group, studied by Barnard, only 6 were due to perforation of gastric or duodenal ulcers; the great majority were caused by appendicitis (10 cases) or hepatic abscesses (7 cases).

2. The right posterior intra-peritoneal region is continuous, between the posterior surface of the right lobe of the liver and the lower ribs, with the right kidney pouch and subhepatic fossa. In its strictly subphrenic region such an abscess would be bounded above by the diaphragm, below by the upper surface of the posterior portion of the right lobe of the liver, in front by the right lateral ligament, and on the left by the reflection of parietal peritoneum covering the right surface of the vena cava and becoming continuous between diaphragm and liver with the coronary and right lateral ligaments of the liver. Abscesses in this situation also are commonly due to infection through the right renal pouch, and so such an abscess may sometimes extend beneath the right lobe of the liver, between it and the transverse mesocolon, across the foramen of Winslow to the anterior surface of the gastro-hepatic omentum, where it will be bounded above by the left lobe of the liver, below by the stomach, in front by the abdominal wall and the diaphragm. Of course, it is also possible, though less usual, for infection to travel in the other direction, starting on the anterior surface of the stomach, passing to the subhepatic region, up the poste-

rior abdominal wall, to become again finally subphrenic. This area is thus seen to be very large and irregular in outline: it includes not only the region above the right lobe of the liver, back of the right lateral ligament, but also the subhepatic space, which has its base in the lateral abdominal wall, and its apex between the left lobe of the liver and the anterior gastric wall. Among Barnard's 76 cases of subphrenic abscess, this region was involved in only 10 cases; and in only 2 of these was the cause gastric or duodenal ulcer.

3. Abscess in the left anterior intra-peritoneal region is bounded above by the diaphragm, below by the left lobe of the liver, on the right by the falciform ligament, on the left by the spleen, posteriorly by the left lateral ligament, and anteriorly by adhesions between the anterior surface of the stomach, the transverse colon, the great omentum, and the abdominal wall. Below the anterior margin of the left lobe of the liver this pouch is continuous on the right with the subhepatic pouch, and on the left with the lumbar pouch, from which infection may reach it by travelling between the spleen and the splenic flexure of the colon. This left anterior intra-peritoneal sub-diaphragmatic region is that which is most often invaded by gastric ulcers which perforate subacutely. Among Barnard's cases, there were 30 instances of suppuration in this space, and 20 of these abscesses were due to gastric and duodenal lesions (16 to gastric ulcer, 2 to gastric cancer, 1 to resection of the stomach, and 1 to duodenal perforation).

4. An abscess in the left posterior intra-peritoneal region arises in the lesser peritoneal cavity. The Spigelian lobe of the liver, which lies in the roof of this cavity (see p. 19), is in contact with the peritoneum covering the left crus of the diaphragm. This portion of the lesser peritoneal cavity is usually the last to be invaded, so that frequently a so-called subphrenic abscess in this region will have no direct relation to the diaphragm. The lesser peritoneal cavity of course communicates through the foramen of Winslow with the subhepatic pouch; but, as is well known, inflammatory processes in this region tend to become encysted by the early obliteration of this foramen by adhesions. It is very rare for an abscess to separate the layers of the great omentum and form a secondary omental abscess. The most usual cause of suppuration in the lesser peritoneal sac is

perforation of a gastric ulcer. Among Barnard's 76 cases there were 3 abscesses in this situation: 2 were due to gastric perforation, the third being caused by suppuration of lymph nodes in the lesser omentum, secondary to cholecystitis. Michel and Gross in 1904 collected 44 instances of suppuration in the lesser peritoneal cavity. They classify the causes thus: 1. Encysted hemorrhage which has become infected, due originally to pancreatitis hæmorrhagica or to trauma. 2. Directly from pancreatitis. 3. Perforation of the stomach. 4. Diseases of the spleen. 5. General peritonitis. Dr. Ashhurst has reported a case of gastric ulcer in which perforation occurred nearly simultaneously on both anterior and posterior walls, producing two subphrenic abscesses, one beneath the left lobe of the liver, anterior to the gastro-hepatic omentum, and the other in the lesser peritoneal cavity.

5. An abscess in the right extra-peritoneal subphrenic region lies between the layers of the coronary, the two lateral, and the falciform ligaments of the liver. The 19 cases observed in Barnard's series were due mostly to abscess of the liver or other forms of hepatic disease; other recognized causes are affections of the right kidney, retro-peritoneal appendicular suppurations, retro-peritoneal duodenal perforations, and occasionally perforation of the diaphragm as the result of thoracic disease. Such abscesses may point in the epigastric region, or rarely at the umbilicus.

6. The left extra-peritoneal subphrenic region is usually infected through the structures around the spinal column or the left kidney. Two of Barnard's cases were due to acute periosteitis of the transverse vertebral processes, a third was caused by an empyema, and "the fourth was probably due to a posterior perforating gastric ulcer," as in the similar case described by Robson.

Cause.—As may be seen from the preceding paragraphs, the causes of subphrenic abscess are many and varied. Among the 252 cases collected by Finkelstein, 67, or 26.6 per cent., were due to lesions of the stomach. From his study of 76 cases Barnard found that 21 were due to gastric, and 5 to duodenal, perforation; while 12 were caused by appendicitis, and 15 by affections of the liver. He concludes that perforated gastric and duodenal ulcers cause about one-

third, appendicitis about one-sixth, hydatid disease and tropical abscess of the liver about one-sixth; the remaining one-third being due to miscellaneous affections.

Pathogenesis.—We may then briefly study the origin and method of infection in these various classes.

Gastric ulcers most often perforate anteriorly. If diffuse peritonitis is not at once produced, the perforation will be subacute, protective adhesions having quickly formed. Under these circumstances the resulting abscess will occupy the apex of the subhepatic fossa, between the left lobe of the liver above, the gastro-hepatic omentum posteriorly, and the stomach below. Unless quickly relieved, such an abscess is prone to leak, producing secondary diffuse peritonitis, usually of the progressive fibrino-purulent form described by Mikulicz. If neither leakage nor rupture occur, the pus usually will work its way around the anterior margin of the left lobe of the liver, invade the left anterior subphrenic space, and form a true subphrenic abscess. Although this anterior perigastric abscess is almost invariably the result of subacute perforation of a gastric ulcer, it may occur on the subsidence of an unoperated diffuse peritonitis due to acute perforation. Such a case has recently been observed by Dr. Ashhurst under Dr. T. R. Neilson's care at the Episcopal Hospital. Perforation of a posterior gastric ulcer causes suppuration in the lesser peritoneal cavity; very rarely has perforation on the extra-peritoneal surface of the stomach led to subphrenic abscess. Sequels of these epigastric abscesses other than fatal peritonitis are rare; but among the results which are occasionally seen may be mentioned the various forms of gastric fistulæ, already described (p. 436); and perforation of the pleura, the lung, the pericardium, etc.

Duodenal ulcers on perforation infect either the right anterior subphrenic region, if intra-peritoneal, or the right retro-peritoneal cellular tissue, if perforation occurs on the posterior or internal surface of the bowel. Intra-peritoneal infection has a marked tendency to gravitate to the right lumbar region, and by invading even the iliac fossa may simulate appendicitis.

Appendicitis itself may give rise to subphrenic abscess in various ways. Elsberg collected 73 such cases, and to these Eisendrath

has recently added 33 others, including 5 of his own. Intra-peritoneal subphrenic abscess is much more often a complication of appendicitis than is extraperitoneal. Among the 106 cases analyzed by Eisendrath, the abscess was intra-peritoneal in two-thirds. In the usual variety the right renal pouch is first affected, then the right posterior intra-peritoneal subphrenic space, including the subhepatic space, and finally the right anterior subphrenic space may be invaded around the right free extremity of the lateral ligament of the liver. Such a patient has recently been operated on at the Episcopal Hospital by Dr. Ashhurst. If the appendix lies to the inner side of the colon, in front of the mesentery of the ileum (a very unusual position), the apex of the subhepatic space may be infected directly, without involvement of the right renal pouch. Extra-peritoneal subphrenic abscess as the result of appendicitis may occur by continuity of tissue, or secondarily through invasion of the liver after suppurative pylephlebitis. The same course of events may of course occur as the result of gastric disease. Eisendrath found recorded only six left-sided cases of subphrenic abscess due to appendicitis.

Hepatic abscess frequently becomes subphrenic by the process of pointing of an abscess through the convex surface of the liver.

Diagnosis.—According to Barnard, in aiming to arrive at a diagnosis in cases of suspected subphrenic abscess, special attention should be paid to the following points:

1. *The Previous History of the Patient.*—The usual *causes* of the condition, *e. g.*, gastric or duodenal ulcer, appendicitis, hepatic abscess, dysentery, etc., must be studied.

2. *The Character of the Onset* is important. If the symptoms were acute, the abscess probably is intra-peritoneal; but if insidious in their origin it is more likely to be situated extra-peritoneally, or in the lesser peritoneal cavity.

3. *The Signs of Pus in general* should be searched for: elevation of temperature, persistent, even if slight; chills; emaciation; thirst; leukocytosis; etc. Other possible regions of suppuration should be excluded.

4. *Abdominal Signs and Symptoms.*—These include bulging, immobility during respiration; tenderness, rigidity; dulness, or

tympany due to the perforation of an air-containing viscus. A swelling due to subphrenic abscess is immobile because fixed by adhesions.

5. *Thoracic Signs and Symptoms.*—These were present in 56 out of the 76 cases of subphrenic abscess studied by Barnard. The most important are: dulness, associated with upward displacement of the lung; diminution or absence of breath sounds, vocal resonance, and vocal fremitus. Occasionally dulness on percussion may be associated with tubular breathing and increased vocal resonance. Amphoric resonance, the coin sound, etc., may be present in abscesses containing air. The apex beat of the heart may be displaced upward, but seldom laterally.

6. *Localizing Signs* should be looked for as an aid to operation. They embrace bulging; tenderness; increase in circumference of the lower thorax on the side affected; œdema; enlargement of the veins, etc. The Roentgen rays should be used if possible.

7. *Aspiration* is dangerous unless followed by immediate operation when pus is found; on the other hand, failure to find pus by no means excludes the presence of an abscess, but may cause the postponement of an operation until it can no longer be of benefit. Hence the needle should not be used until the patient is on the operating table ready for any operation that may seem proper.

Prognosis.—The prognosis of subphrenic abscess is bad, no matter what the treatment; but it is very much worse if no operation is done, or if operative treatment is too long delayed. Among Barnard's cases there were 64 patients treated by 73 operations; of this number 40 patients recovered, and 24 died, a general mortality of 37.5 per cent. Death resulted in every patient not operated upon. Among the 44 cases of suppuration in the lesser peritoneal cavity collected by Michel and Gross, there were 19 patients treated by operation; all those not operated upon died, while of the others only 9 died, a death rate of 47.36 per cent. Of the patients with subphrenic abscess following appendicitis, studied by Eisendrath, 84 were treated by operation, with 23 deaths, a mortality of 27.38 per cent.; while the death rate among patients not operated upon was over 82 per cent.

Barnard concludes that, speaking in a general manner, posterior

methods of drainage give more favourable results than do the anterior. In his series of cases, 26 posterior operations were performed, with 7 deaths (27 per cent.); 43 anterior operations, with 17 deaths (39.5 per cent.); and 4 lateral, with 3 deaths (75 per cent.). He has himself performed 24 operations on 21 patients for subphrenic abscess; 15 of these operations were posterior, with 2 deaths (13.3 per cent.); and 9 were anterior, with 2 deaths (22.2 per cent.).

Treatment.—The operations for subphrenic abscess may be classed in accordance with Barnard's tables, as anterior, posterior, and lateral. The former include abdominal incisions, whether in the epigastrium or in one of the hypochondriac regions. The posterior operations include the subpleural and transpleural approaches through the diaphragm; they resemble the usual operations for hepatic abscess, which will be described in connection with that lesion in Volume II. Lateral transpleural or subpleural operations should not be attempted unless the abscess is very manifestly pointing in the axillary line.

When the existence of subphrenic abscess is suspected, it is sometimes better, as pointed out by Barnard, to delay operation for three or four days in order to allow the abscess to become more accessible. This applies particularly to infections beneath the right dome of the diaphragm, secondary to disease of the liver. When the abscess is believed to be in other situations we believe delay to be dangerous, and think an exploratory laparotomy should be undertaken as soon as the presence of pus is reasonably certain, even though its exact location cannot be pre-determined. By opening the peritoneal cavity and cautiously disposing gauze packs before attempting any exploration whatever, or before rupturing any adhesions, it usually will be possible to discover the situation of the abscess, and then to approach it by the thoracic or lumbar route should such a course be advisable. Especially dangerous is delay in those subphrenic or perigastric abscesses which arise as the localized remains of a diffuse peritonitis (residual abscesses). In such cases the limiting adhesions are never so firm as in subacute or chronic perforations, and unless the abscess be evacuated so soon as its presence is detected, it will be sure to break again and produce spreading fibrino-purulent peritonitis.

The use of the exploring needle may be preferred to laparotomy when the patient, prepared for operation, is on the operating table, and the surgeon has good reason to believe that the abscess is beneath the costal margin. Attention to the known pathogenesis of subphrenic abscess will frequently enable this point to be ascertained with reasonable certainty.

In all cases in which the abscess has to be approached by the anterior (abdominal) route it will be much safer for the surgeon to open it transperitoneally after thoroughly protecting all surrounding structures by gauze packs, than for him to attempt to cut directly into the abscess cavity. In the latter method of operating the surgeon can never be entirely sure that his incision itself has not trespassed beyond the limiting adhesions, nor that his manipulations have not produced leakage into the general peritoneal cavity at some other point of the abscess's periphery.

For *anterior perigastric abscess*, median or left hypochondriac laparotomy is to be preferred. Drainage may be provided for by a counter opening in the left flank, if the abscess extends far toward the spleen.

For *posterior perigastric abscess* (suppuration in the lesser cavity of the peritoneum), laparotomy should be done, and the abscess opened where most prominent—whether it points through the gastro-hepatic or through the gastro-colic omentum, or through the transverse mesocolon. Though recovery has followed anterior drainage alone, it is much safer to make a counter opening in the left loin, below the last rib; under such circumstances it is occasionally proper to close the anterior incision without drainage. If the location of the abscess in the lesser peritoneal cavity has been determined before operation, an attempt should be made to open it through the left ilio-costal space. This route has been employed twice successfully by Dr. Deaver, once as the primary operation, and once after locating the abscess by laparotomy.

For a subphrenic abscess which involves the *subhepatic space* and right renal pouch, laparotomy combined with counter-drainage in the right loin should be employed.

When the abscess does not extend beyond the confines of the costal

margin on the right it is sufficient to drain it by the thoracic incision.

The thoracic operation should never be employed if there be diffuse peritonitis. In the presence of this additional complication there is a choice of two methods of procedure: 1. If it appear that the patient will survive the immediate shock of an operation, laparotomy should be done, the cause of the peritonitis abated, and drainage of the pelvis provided for, as well as of the side of the subphrenic space involved. 2. If the peritonitis has advanced so far that no operation can be undertaken without great probability of hastening the patient's death, the starvation treatment of Ochsner should be adopted; but any localized collection of pus must be opened as soon as it is discovered—delay of even twelve hours may place the patient beyond the reach of surgery. Whichever plan of treatment be adopted, the head of the patient's bed should be raised 30 degress from the floor (Fowler's position), to aid the gravitation of septic fluids to the pelvis. Saline solution should be constantly administered by the bowel.

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